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Mechanization of Cotton Production

By Wm. E. Meek

MEMBER A.S.A.E.

A FARMER contemplating complete mechanization will be confronted with the necessity of making many changes. Road location, field layout, removal of tenant houses and other buildings to the property line, modification of ditches and drainage systems to more nearly adapt them to the operation of power equipment, cropping practices, and equipment for field operation, must all be given consideration. The new methods will constitute a real departure from plantation practices of many years' standing, and breaking the barriers of tradition may be very difficult. The farmer must realize, however, that modern equipment requires modern methods.

Mechanized farming is precision farming. To obtain precision, uniformity is essential. Crop rows must be uniformly spaced and of uniform height and shape. From seedbed preparation through planting and cultivating, uniformity must be paramount. It cannot be overemphasized. To attain uniformity, the proper implements must be used and used correctly. Good operation and close supervision are essentials for mechanized farming.

Timeliness is most important and can be had only by an adequate amount of field equipment. The equipment necessary to time the various operations most advantageously will represent a high investment per acre. When the farmer realizes how much he has invested in field equipment, not to mention his buildings and stationary equipment, he will also realize the need for good management and careful supervision. These are essential if the operation is to be a successful one.

The time to start preparations for a mechanized crop is when disposing of the crop residues from previous crops. A good stalk cutter will pay dividends as the stalks should be cut into small pieces. When properly cut the stalks will give far less trouble from clogging when plowing, planting, and cultivating; also, when cut into small pieces, they will rot faster. Proper disposal of crop residues pays dividends the entire crop year and is an operation that should not be slighted.

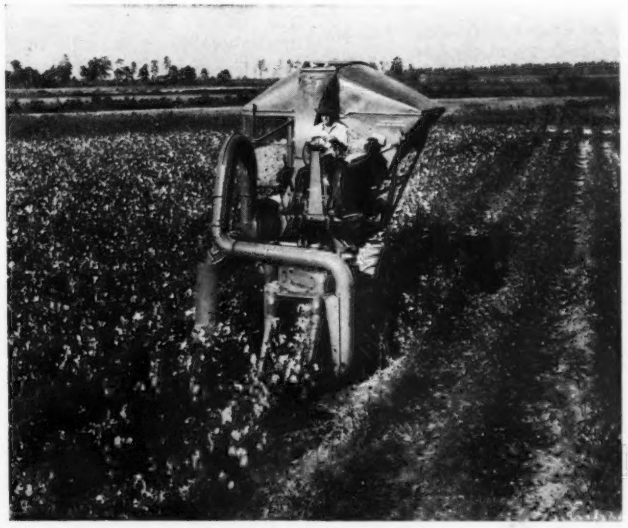
Following crop residue disposal is seedbed preparation which may be done with a plow, breaking the land flat, or with the middlebreaker by bedding the land into rows or beds. Both of these practices have been found to be satisfactory, but because of the increased acreage per day of the middlebreaker over the plow, the timeliness of middlebreaking makes this method a more popular practice with planters of the Mississippi Delta. As a rule, better drainage can be secured by flat breaking, unless the middlebreaker rows are run on the contour. When a bed made by the middlebreaker crosses the natural drainage pattern, it becomes a dam. When the rows are run on the contour, however, the middles between the beds serve as ditches to carry the water off the land.

If the middlebreaker is used, it should be of the modern three-row type. Old-style, rear-mounted, two-row middlebreakers make it practically impossible to obtain beds of uniform height as one wheel of the tractor runs on the bed. This gives rows of alternate heights and densities. With the three-row machines, each rear wheel of the tractor runs in a middle behind the bottom. This gives better traction to the tractor, and as the third bottom is behind the front wheels, beds of uniform height and density are the result. If a marker is used, then uniform row widths can be more nearly assured. Where the tractor does not have sufficient power to carry three bottoms, the center bottom may be left off, and the implement then becomes a two-row, skip-row middlebreaker. With these two-row machines, beds of uniform height and density can be had as the tractor wheels still run in the middles and not on the beds.

When the moldboard plow is used for seedbed preparation fertilizer can be applied at the time of breaking by equipping the plow with a fertilizer attachment. These attachments allow the fertilizer to be applied at plowing depth. They are simple, easily cleaned, readily adjusted, and are most satisfactory.

With the middlebreaking, either tractor-mounted or trailing fertilizer distributors are used. The land may be bedded and the fertilizer applied in the middles, being covered by the rebedding operation. This method of bedding and rebedding puts the crop row in the same location each year. Another method is to "center-furrow" or sink the old middles deeper with the middlebreaker, deposit the fertilizer, and bed onto it for coverage. This method tends to place the fertilizer a bit deeper and changes the location of the rows each year. Both of these methods are widely used when applying nitrogenous fertilizers, and it is usually a matter of personal preference as to which method is selected.

Where complete fertilizers are used rather than nitrogen alone, they are often applied at planting time. When this is done, the planters may be equipped with a fertilizer attachment which will deposit the fertilizer in correct relation to the seed. This method of fertilizer application is usually fol-



A high point in the mechanization of cotton production is reached in the success of the mechanical cotton picker. This new International Harvester machine can pick, doff, and clean cotton at the rate of approximately one acre per hour

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Philadelphia, Pa., June, 1947, as a contribution of the Power and Machinery Division.

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lowed when two-row equipment is used, as few of the four-row cotton planters are capable of being equipped with fertilizer attachments.

Planting of the cotton crop may be done in several ways. When mechanized, one practice is to drill the cotton, and then mechanically chop or block it to a stand. Several mechanical choppers or blockers are available to the farmer. When flame cultivation is practiced, the cotton may be thinned or blocked to a stand by flame chopping[1]. The flame chopper is an attachment for the flame cultivator and consists of wheels on which are mounted open-end buckets or boxes which are pulled down the crop row. The boxes protect the plants which they encase, and the unwanted plants are killed by the flame of the cultivator burners. Flame chopping tends to give better grass and weed control during the earlier stages of growth in the hill as well as in the drill when compared with mechanical chopping or hill dropping. When chopping to a stand, either mechanically or with flame, the operation should be done as soon as a stand is assured. A poor stand at the start of the thinning operation will almost invariably be poorer when the operation is completed.

HILL-DROP ATTACHMENT SAVES SEED

Still another method is that of hill dropping to a stand. Here the planter is equipped with a hill-drop attachment which deposits the desired number of seeds in hills spaced at the distance selected. This method saves considerable seed and has proved to be a most satisfactory practice.

Where the topography of the land permits, cross cultivation has been found to be a most efficient method of weed and grass control in the crop. With two-row planters the cotton, either undelinted or delinted, can be planted to a stand with the desired number of seeds per hill. With four-row planters the seed should be more closely delinted as few of these machines are adaptable to seed with any appreciable amount of lint or fuzz. The difficulty in obtaining a check with four-row planters, together with the necessity of close delinting, has greatly curtailed their use. When check planting either with two or four-row planters, great care should be exercised to see that the fields are clear of stalks and trash which might impede the movement of the checkrow wire in planting. Checkrow planting on bedded land has not as a rule been satisfactory.

A common practice where cross cultivation is to be followed is to drill the cotton rather than plant it to a check. The field is then cross-plowed to a stand with the cultivator, which in this case serves as a blocker to take out the unwanted plants. As in mechanical chopping, this should be done as soon as a stand is assured. For best results, the cultivator should be equipped with disk hillers for the blocking operation. The hillers are usually set to leave from 6 to 18 plants per hill. On land that is capable of producing a bale of cotton per acre or better, checked cotton will yield about the same amount of seed cotton per acre as cotton that has been drilled and then chopped to a stand or where hill dropping is practiced. During the blocking operation, where cross-cultivation is to be practiced, a marker will be of great advantage as a more uniform row spacing can be had.

After breaking the land, the matter of preparing the seedbed for planting should be given careful consideration. A common plantation practice is to disk the beds down with a disk harrow, following this with a peg-tooth or spike-tooth harrow to complete the leveling. On flat-broken land, the same procedure is usually followed. When this method is employed with four-row equipment, three disk harrows and two peg-tooth harrows are usually required to prepare the seedbed for two four-row planters. This requires seven tractors and from seven to nine men, depending on the type of planter used. A method developed at the Delta Experiment Station allows two tractors to do the same operation. With this method, a four-row cultivator is mounted on the front of the tractor with the sweeps carefully set as for the first cultivation of the crop. On the rear of the tractor, a four-row planter is mounted. The cultivator is used to prepare the seedbed just prior to planting. The cultivator sweeps loosen the bed where middlebreaking has been practiced, so that wings attached to each planter runner are enabled to sweep the loose dirt from the beds and into the middles. Any grass or weed seeds in the warm crust of the bed are thereby carried to the middles where they can be more easily controlled by cultivation. The cultivator-planter combination may also be used on flat-broken land. Here the sweeps are run just deep enough to break the crust. The method has proved to be satisfactory on both bedded and flat-broken land.

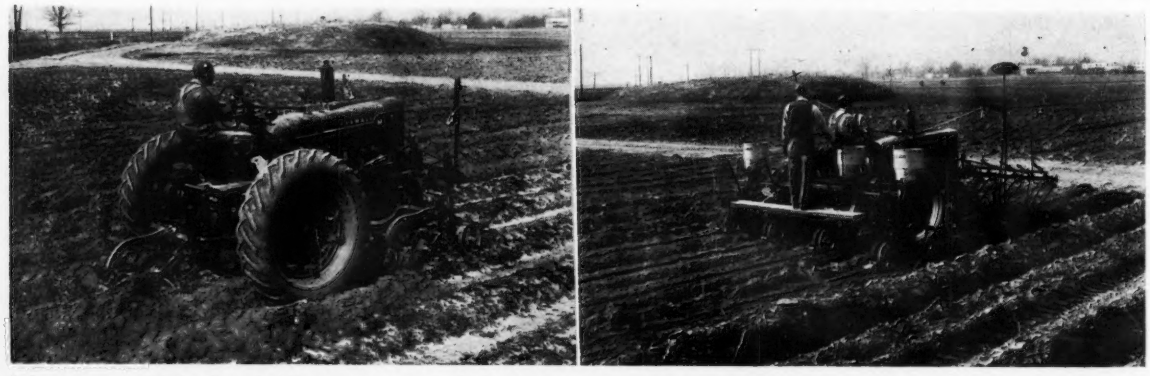
CULTIVATOR-PLANTER COMBINATION HAS ADVANTAGES

By the use of a properly adjusted cultivator-planter combination, great uniformity is attained in both the crop rows and the middles, and higher speeds are thereby possible for the first cultivations.

The cultivator-planter combination offers another advantage. Low spots in the field often are not dry enough to plant when the planting operation is in progress. During the first cultivation, the planter may be left on the tractor, and, when cultivating the first time, the planter may be lowered so as to plant these unplanted areas.

After the cultivator is mounted on the tractor, it is taken to the farm shop where it is adjusted and properly set. On the shop floor, lines are painted which represent the rows and the middles. A long center line, representing the center middle, serves as a guide for aligning the tractor with the rows. The operator drives the tractor onto the line diagram so that the center line is centered by the front wheels. When the cross line is reached, the tractor will be in proper alignment with the rows. The cultivator gangs are then lowered to the floor for adjustment. The gang beams are first set level or parallel with the floor. They are also properly spaced so as to allow the sweeps to be set the right distance from the drill. The front pair of sweeps which are nearest the row will be so

[1]Gull, P. W., Baggette, T. L., et al. Unpublished data, Delta Branch, Mississippi Agricultural Experiment Station.



Left: A 3-row middlebreaker rebedding cotton rows • *Right:* A 4-row cotton planter with hill-dropping attachment and a 4-row cultivator as used at the Mississippi Delta Branch Experiment Station

Left: The two-row Gotcher flame cultivator. (Picture taken at dusk to show flame pattern) • *Right:* Butane-burning Farmall tractor with 4-row cultivator equipped with rotary hoe attachments and with a 4-row New Holland ("Sizz-Weeder") flame cultivator mounted on the rear, in the operation of flame-chopping young cotton

spaced that they will be about 10 to 12 in apart, measuring from wing to wing. The second pair of sweeps is then located so as to lap the cut of the front sweeps, the distance from wing to wing being about 18 in. These sweeps are of 8-in size. The third pair of sweeps runs directly in the middle and are of 10-in size. They are set directly on the line which represents the middle.

This setting of the sweeps will be maintained with very little change from planting until lay-by time, unless adverse weather conditions or some other unusual situation should be encountered which would indicate the need for more fore-and-aft clearance between the sweeps. This might be, as an example, an unduly heavy growth of grass and weeds. In such an event, it may be necessary to move the gangs outward somewhat so as to put larger sweeps next to the row. The middle or second pair of sweeps would then be left off, and the third or middle sweep would be increased in size to about 12 or 14 in.

After the sweeps are properly placed in relation to the crop row and the middle, they are then set so as to be *flat* on the floor. No pitch or tilt is given them for penetration, as it will be found that there is enough looseness in the joints of the cultivator to give the necessary pitch for proper penetration.

SHALLOW CULTIVATION PREFERRED IN MANY INSTANCES

Since cultivation is primarily for grass and weed control, shallow cultivation is preferred. Also with flame cultivation, it is most undesirable to throw dirt to the plants, or, in the farmer's language, "dirt the cotton". Shallow cultivation throws less dirt as the sweeps are not required to handle as much soil as when set deep. It also permits extremely high-speed cultivation, particularly if the Texas-type sweep is used. This is a sweep especially well adapted to shallow high-speed cultivation. By shallow cultivation, weed and grass seed are not continually being brought to the surface to germinate and grow. Control is made easier. Shallow cultivation also throws less strain on the sweeps, the cultivator, and the tractor, thereby reducing wear, minimizing breakage, and reducing operating costs.

All sweeps used are of 3/16-in thickness, and being set flat they tend to wear in a self-sharpening manner. This setting of the sweeps tends to make them wear less, stay sharp, and to wear down at the same angle as when new. On the Delta Station sweeps are never sharpened either in the forge or on an emery.

In the cultivation of southern crops, particularly cotton, many types, shapes, and sizes of sweeps are used. The first sweeps used on tractor cultivators were naturally the same as those in use with horse-drawn equipment. Some changes were made as time went on, but not until the advent of the pneumatic-tired tractors with their greatly increased speeds were there any radical changes made in the general design of sweeps. While there are still many different types in use, four types are the most common and are more universally used.

Probably the most popular of all southern sweeps is the Joyce type which is a general-purpose-type sweep and is sometimes referred to as a "mixed-land" sweep. It is characterized by a rather broad angle and a medium crown. It is usually made in both the 3/16-in and ¼-in thicknesses and in sizes ranging from 6 to 18 in. The 6, 8, and 10-in sizes are also available as half sweeps, both right and left-hand. This is a good general-purpose sweep and throws a medium amount of dirt toward the crop row. It is adaptable to both deep and shallow cultivation and can be used at moderate cultivation speeds without throwing an excessive amount of dirt.

A second sweep is the McGregor sweep which is often called a "blackland" sweep. It differs from the Joyce in that it has a rather sharp angle and a high crown. Like the Joyce it is made in both the 3/16-in and ¼-in thicknesses and runs in sizes from 4 to 20 in. Half sweeps are not available. This sweep was used in the days of steel-wheeled tractors with their rather slow working speed, and was then very popular as it would throw a considerable amount of dirt to the crop row even at those low speeds. The advent of the faster pneumatic-tired tractors has caused the popularity of the McGregor-type sweep to wane considerably, although it is still popular in some localities.

A NEW SWEEP THAT CAN BE RUN AT HIGHER SPEEDS

A new sweep that has become popular in certain areas is the "hi-speed" sweep which has a broad angle and a medium-low crown. It is made in the 3/16-in thickness only and in sizes ranging from 8 to 12 in. All sizes are available as half sweeps in both the right and left hand. This sweep throws a fair amount of dirt at high speeds and is very adaptable for shallow cultivation. It does not throw as much dirt as the Joyce, and can consequently be used at higher speeds.

A fourth type is the "Texas" sweep. This sweep has a sharp angle very similar to the McGregor, but with a very low crown. It is made in sizes ranging from 4 to 42 in and in thickness ranging from 5/32 in in the smaller sizes to ¼ in in the medium and large sizes. Probably no type of sweep offers as many sizes and thicknesses as does the Texas. Sizes from 24 to 32 in can usually be had in half sweeps, both right and left hand. This sweep is admirably suited to high-speed cultivation as the sharp angle and low crown tend to throw a minimum amount of dirt. Where flame cultivation is to be practiced as a part of the mechanized farming program, it is probably the best of the available types. It can be operated at speeds in excess of 5 mph and with only a small amount of dirt being thrown to the crop row. It is admirably adapted to shallow cultivation. *(Continued on page 547)*

Concrete Mow Floors for Dairy Barns

By G. L. Nelson
MEMBER A.S.A.E.

AGRICULTURAL engineers in the farm structures field have made good progress in developing dairy barns that are easy to keep clean and that help reduce chore labor. Equally important is a barn that protects the cattle and men in the barn from injury and destruction. It is a wonderful achievement for the dairy farmer to acquire a healthy, high-producing herd, and to house it in a barn that puts milk production on a highly sanitary, efficient basis. It is a disaster to both the farm and the community if that herd is destroyed in a barn fire originating in the mow or maimed by wreckage of the barn during a windstorm. In such an event, all efforts towards sanitation and convenience in that particular barn have been wasted.

The more the farmer improves his dairy herd and takes pains to build a barn that is sanitary and highly efficient, the poorer his management becomes by risking these investments in a barn where the cattle and men are exposed to the hazards of mow fires, windstorms, and other accidents.

Contribution to a round-table discussion at the Dairy Housing Conference sponsored by the Farm Structures Division of the American Society of Agricultural Engineers, at Madison, Wis., July, 1947.

G. L. NELSON, formerly senior agricultural engineer, Portland Cement Assn., is now associate professor of agricultural engineering, Oklahoma A. & M. College.

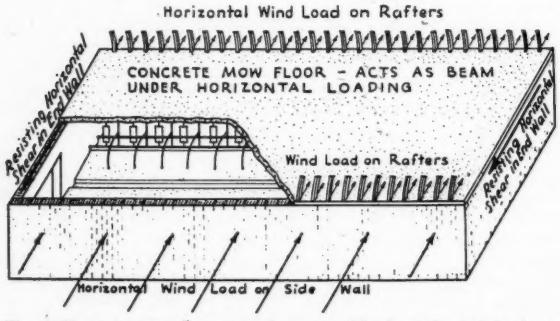

Horizontal Wind Load on Rafters
CONCRETE MOW FLOOR - ACTS AS BEAM UNDER HORIZONTAL LOADING
Resisting Horizontal Shear in End Wall
Wind Load on Rafters
Resisting Horizontal Shear in End Wall
Horizontal Wind Load on Side Wall

Fig. 1 Concrete mow floors transfer part of horizontal wind loads on rafters and sidewalls to the end walls

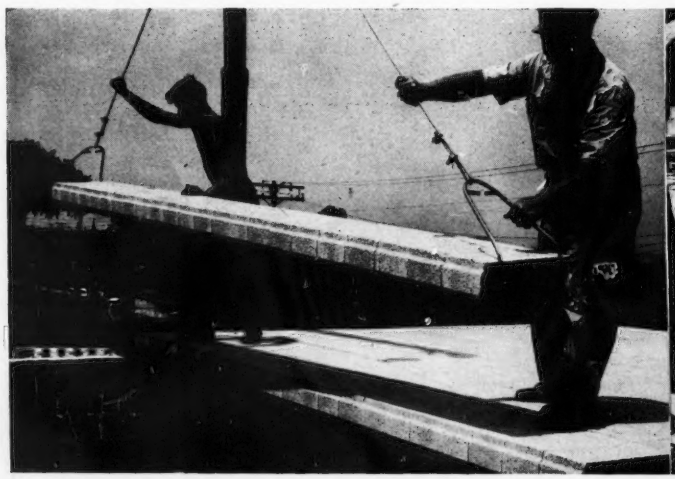
A concrete mow floor for the dairy barn is one effective safeguard against hazards connected with overhead hay storage. Concrete mow floors will not burn. They are a firesafe barrier between inflammable material in the mow and the cattle sheltered below.

A farmer near Lake Odessa, Mich., Morris Carter, has recently built a 36x72-ft dairy barn with a cast-in-place mow floor. Mr. Carter has a profitable business in breeding and selling registered Jersey cattle. When asked what prompted him to put a concrete mow floor in the new barn, he said that he wanted to do everything possible to protect his herd. He asserted that his investment in a firesafe mow floor would be more than justified if it helped him save just one cow, in the event that the hayloft burned. The threat of a barn fire was very real to Mr. Carter, for his new barn was going up on the site of an old barn which had burned, destroying all the livestock and causing the death of the previous owner.

A fire several years ago at the Mooseheart Industrial School about 30 miles west of Chicago provides another illustration of the effectiveness of firesafe mow floor construction. Fire broke out in the haymow of the main dairy barn built with a concrete mow floor. When the fire was discovered, the entire hayloft was ablaze. Even so, attendants were able to remove the entire herd of Holsteins, valued at $30,000. The fire eventually burned out after the hayloft and everything in it were gone, but the concrete first story walls and the concrete mow floor were undamaged. While the fire was still smoldering overhead, the cows were put back in their stalls and milked. They were fed silage from the concrete silo adjoining the barn. The silo had gone through the fire unscathed.

Concrete mow floors also contribute to farm safety by stiffening the first story against windstorm destruction. When the barn is subjected to wind forces as shown in Fig. 1, the concrete mow floor transfers part of the horizontal wind load on sidewalls and rafters to the end walls. This load transfer is possible because a concrete mow floor, being essentially a one-piece structure, can develop beam action under horizontal loads. Therefore, the floor will restrain the sidewalls against inward or outward collapse under large wind pressures. Even though the hayloft roof is carried away, the first story can continue to shelter and protect the cattle and workers.

Fire and windstorm are two very serious hazards to guard



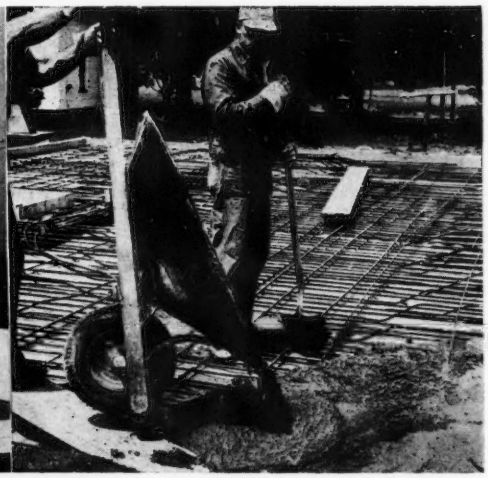


Fig. 2 *(Left)* Precast items for concrete mow floor construction are available in many communities. Cored concrete planks assembled in a factory from special lightweight concrete block are being used on this job • Fig. 3 *(Right)* Reinforced cast-in-place concrete is often used for firesafe mow floor construction. Reinforcement is delivered to the job already cut and bent to size

against in dairy barn design and construction. Concrete mow floors also help to eliminate other hazards. Many accidents to men on the farm have been caused by falls on mow floors made slippery by the polishing action of the hay, particularly around hay chute openings. Concrete mow floors can readily be given a non-skid, wear-resistant finish when the concrete is placed. This helps reduce the danger of disabling falls. Other hazards eliminated by concrete mow floors are loose boards, projecting nails, and broken sections, any of which could cause a serious accident to the worker in the mow.

Even though farm structures engineers recognize the protection afforded by a concrete mow floor, they are sometimes not sufficiently familiar with the techniques of reinforced concrete design and construction so that they can readily prepare working drawings for the builder. To help overcome this situation the Portland Cement Association has prepared typical design and construction information on some of the types of suspended concrete floor construction in general use; this material is available on request to the Association. In many communities, products plants have developed special precast items for suspended concrete floor construction. In other localities, the local builder has developed his own techniques for building concrete mow floors. For this reason local builders should always be consulted for the type of concrete mow floor construction they are best equipped to handle. It is important that the builder be provided with complete working drawings prepared by a qualified engineer, before concrete mow floor construction is attempted.

Cotton Production

(Continued from page 545)

Where the cultivator was used in conjunction with the planter, the crop rows were shaped or formed at planting time as has been previously stated. When the cotton plants are small and the first cultivation is to be made, the crop row and middle have already had, in effect, one cultivation. This leaves them in excellent condition for high-speed cultivation. At this time a rotary-hoe[2] attachment is added to the cultivator in such a manner that the hoe wheels, four in number, are directly over the drill and between the front pair of sweeps. These hoe wheels, traveling at high speed, cultivate in and around the young cotton plants in the row and also act as shields for the sweeps, preventing them from throwing too much dirt in the drill. The rotary-hoe attachments are independent of the cultivator gangs and are free to float or may be set at the desired depth, which is just deep enough to break the crust. With this attachment cotton can be cultivated the first time at speeds up to 5½ mph with four-row equipment. This greatly reduces the cost of operation and allows a timeliness through faster cultivation that is most important. The rotary-hoe attachment may be used for the first two or three cultivations, or until the plants are about 8 to 10 in tall. If desired, pipe spacers may be substituted for the two center wheels, leaving the outer wheels to act as shields or fenders for the sweeps.

When the stem of the cotton plant has reached a diameter of about 3/16 in at the ground line, flaming will be started. At this time, the plants will be from 6 to 10 in tall. When the stem of the plant reaches this size, it will have developed a tough outer bark that is resistant to the intense heat of the burners. Cultivation and flaming are carried on as one operation with the regular cultivator sweep mounted on the front of the tractor and the flame cultivator on the rear. Consequently this combining of the two operations of cultivating of middles and the flaming of the crop row greatly reduces the cost of operation.

Flame does not, as many believe, flow or follow the contour of the bed, but is, in fact, deflected by ridges of dirt thrown to the drill or even by large clods. It is undesirable, therefore, to dirt the crop row. For maximum benefit from the flame cultivator, the beds should be as flat as possible so that the flame will have a tendency to spread flatly over the drill, killing the small weeds and grasses on each side as well as in the drill itself.

Assuming that the proper height of cotton for flaming is about 8 in, and the proper diameter is about 3/16 in, if it is then dirted with 3 in of dirt, there is not enough soil on top of the grass and weeds to really retard their growth to any appreciable extent. The roots have not been disturbed, and there is only a thin layer of dirt on the outer edges of the dirt ridge thrown to the drill. After this dirting process, the plant is only about 5 in tall instead of 8 in, and the stem has a diameter of only about ⅛ in at the ground line instead of the 3/16 in. The plant is not large enough, therefore, for safe flaming, and in the time that it takes to grow again to the proper size, the grass and weeds may break through the thin layer of soil on the outer edges of the dirt ridge, and with a well-established root system, grow to such a size that only hand hoeing will remove them. Also a ridge of dirt has been thrown along the drill which makes it extremely difficult, if not impossible, to properly set the flame cultivator burners. By leaving the drill flat, the flame cultivator can be set to obtain the maximum benefit from the flaming process, thereby controlling grass and weeds over a wide area alongside the drill. This permits a wider setting of the sweeps and reduces root pruning to a minimum.

SPEED CAN BE INCREASED WITH DOUBLE BURNERS

Where the flame cultivator is equipped with double burners, the tractor can be speeded up to about 4½ mph instead of the 2¾ to 3 mph when the single burner is used. It is doubtful whether or not young cotton can withstand the heat of the double burners at the same stage of growth as where the single burner can be safely used. It may be desirable, therefore, to make the first and second flamings of the crop with single burners and then add additional burners for the subsequent flamings. Simultaneous cultivation and flaming is repeated at from four to six-day intervals during the entire cultivating season.

Cultivation and flaming is continued until late in the season so as to better control the growth of late vines and weeds. This not only contributes to cleaner fields in ensuing years, but greatly reduces the amount of green matter in the fields at picking time. Green weeds and particularly vines are most undesirable when mechanical pickers are used. They are not, as a rule, affected by the defoliant as is the cotton plant. It may be, therefore, a good practice to use a certain amount of hand labor to remove any late-growing weeds in the field before they go to seed as an aid in the weed control of succeeding crops.

Shallow cultivation is practiced throughout the crop season, and in addition to its other advantages, a firmer middle is left which gives the mechanical cotton picker a better footing, particularly if fall rains should be the rule.

About the time the cotton has matured and immediately prior to harvesting, the plants are defoliated. The airplane is usually preferred for the application of defoliants as it is efficient, fast, inexpensive, and does not injure the crop as ground machines are likely to do. If, however, airplanes are not available, then ground machines must be used. These are the same machines as are used for the application of poison dust for insect control. The tractor, however, should be equipped with fenders so as to reduce the crop damage to a minimum. Defoliation prior to machine picking is very desirable as it reduces the green leaf in the sample and thereby increases the grade. The removal of the heavy foliage also tends to reduce boll rot, and the crop seems to have a tendency to open faster.

Mechanical harvesters used are of two types, the stripper and the spindle-type picker. Strippers have not proved to be satisfactory except in certain areas, mostly in Texas. Their use is not, therefore, widespread. They lower the grade more than the spindle-type pickers and give a rather trashy sample.

The use of the spindle-type picker is limited by the extremely small quantity manufactured to date. While the present machines might be classified as heavy, complicated, and expensive, they do very good work and are satisfactory except under very wet ground conditions where it is impossible for the traction wheels of the tractor power unit to obtain a footing. As manufacturing facilities are increased, more machines will be available to the farmers, and the harvesting of the cotton crop will be greatly speeded up and at a lesser cost for harvesting per bale.

[2]Patent applied for by H. H. Hopson and Wm. E. Meek.

Farm Engineering in Flame Cultivation

By Thomas L. Baggette
MEMBER A.S.A.E.

THERE has been produced for institutional use a montage photograph depicting the story of flame. The picture shows a history of flame that is highly significant to the agricultural engineer. In the upper right-hand corner of the picture is the Temple of Olympia from which, according to Greek mythology, the god Prometheus stole flame for the use of man. In the lower right-hand corner is a picture of a flame cultivator, the latest and newest use to which man has put flame — that of row crop burning for cultivation purposes.

The rest of the picture is the Promethean moth common to southern climes and so named because of a streak of flame on its wing. This montage is significant because of the economic and social implications flame cultivation carries with it; and also because the picture contains an error. Flame cultivation belongs not just to the South, though its development and use have thus far been located there. Flame cultivation belongs to, and in, all agriculture.

The use of flame for undesirable vegetation eradication is not new. Burners of various types from a plumber's blowtorch to the massive machines of the railway systems have been used to kill weeds. But selective burning for the control of weeds and grasses within a specific crop is something new. It is new in the field of actual farm operations, and it is new in the field of agricultural engineering. Agricultural engineers must grasp and understand the principle that while flame cultivation is destructive in its use, it is productive in its intent.

Flame cultivation means a different type of land preparation, different drainage systems, new machines and new cultural practices. None of these things is perfected as yet, but all can be when the leaders of American agricultural engineering believe that in present and future use of flame for cultivating agricultural crops lies a new era for American agriculture.

Selective burning was first conceived and used by Price C. McLemore in cotton. Next, flame cultivation was successfully tested in pineapple and then returned to cotton. The spectacular success with which it has been used in that crop is a matter of record, and many changes have come about in the machine itself as problems of operation arose, were solved, and maximum efficiency of operation sought. The latter is a never-ending search that will result in even more significant changes and contributions.

Keeping areas to be flamed flat and free from any causes of flame deflection has presented an educational problem second to none. Farmers have been encouraged to plant flat wherever possible. Many areas of this country must necessarily bed their crops either to effect rapid drainage, to slow down water runoff, or to provide channels for irrigation. Even so, those farmers who use flame on bedded crops were, and are, urged to prepare with three-row busters to attain uniformity of height of bed and to drag the top of the bed as flat as possible. In the case of irrigation channels, the size of furrows between rows is such that the heavy equipment necessary to make those furrows creates large clods. In other areas, soil types may create the same situation under certain moisture conditions with even a minimum of row cultivation. The principal task wherever flame is used for cultivation is to keep the seedbed or drill flat and to avoid any cause for deflection of flame into the cultivated crop.

A second field engineering problem — and there are only two — that makes a difference in a general application of flame cultivation principles the country over, is encountered where a crop is dependent on soil absorption of water from the ground level rather than from rain. The placement of the flame cultivator unit on the rear of a tractor has necessitated the dropping of any rear sweeps in order to facilitate mounting the flaming unit. Such deletion of equipment is of no major importance except in irrigated sections. The heavy load of cultivator sweeps on the front of a tractor, plus the flame cultivator on the rear, creates a heavy row pack by the large rear wheels and a significant one by the front wheels. Some type of soil disturbance is necessary after this packing to recreate the desirable condition conducive to capillary water penetration through the soil. So far, sweeps on the rear of the flame cultivator skids, which follow the wheels, have met with fair success in loosening any pack, but the problem has not been solved. These sweeps must have a perfect line of draft with the skid itself or the burner will be thrown out of line. The sweep must be locked in place so that it will actually take the ground and plow, not ride on its point. In addition, it must be spring or friction set so when it encounters a snag, stone, or some other immovable object, it will trip up and not be broken.

Such discussion always brings up the question: why not mount the flamer on the front of the tractor? The temperature range on a flame cultivator burner is from 1800 to 2200F (degrees Fahrenheit). Two burners per row, four rows per unit, builds up an intensity of heat that has been known to boil the oil in the tractor crankcase and melt the tires on the front of the machine. These facts, together with the human factor of the tractor driver having to face into that heat, caused the abandonment of this type placement early in flame cultivation testing work. There is, of course, the possibility of using shields to protect the operator and this has been done to some extent.

Another factor in rear placement of the flame cultivator is that once burners are properly set, the flame cultivator needs no further attention from the tractor operator as the skids follow the furrows plowed. This is true, providing rows or beds are of even height and correctly spaced.

One of the most desirable and advantageous practices in flame cultivation is the multiple use of tractors by mounting both conventional cultivating equipment and flame cultivators on one tractor. By cultivating both the middles and the crop row itself, the number of trips through the field is cut by one-half, manpower requirements cut in half, fuel costs reduced by fifty per cent, tractor numbers per unit of acres reduced, and depreciation and operating costs materially cut.

Cultivating equipment prepares the way for the flame burner skids and the multiple equipment makes for better balance on the tractor, and thus better steering.

Complaints are made that in using the flame cultivator with other cultivation equipment the first one or two times through

This view of a four-row flame cultivator shows the machine entering the crop rows with the burners correctly set to give maximum weed and grass control with minimum damage to the crop

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the crop, the tractor has to travel in low gear and the total number of acres covered per day is thus materially reduced. This is more than offset, however, by the fact that the number of tractors needed in the field is cut in half, and particularly is this important in these days of severe tractor shortages. Also, reduction in fuel and labor requirements is an offset. After the crop is up and, to be assumed, reasonably free of weeds and grass because of the two early flamings, burner pressures can be increased and tractors put in second and third gear.

Flame cultivation has been tested and proven in many row crops. In addition to cotton, sugar cane, and pineapple, where most of the developmental work has been done, the flame cultivator has operated successfully in soybeans, corn, grain sorghums; in truck crops such as onions, asparagus, Irish potatoes, tomatoes, carrots, lima and snap beans; in nursery stock such as rose bushes, evergreens, cottonwood seedlings, blueberries; in bulb plants such as gladiolas; in seed flowers as delphiniums; and in vineyards, to mention only a few. Flame cultivation has been successful in the broadcast crop of alfalfa when used after a cutting has been made.

The New York Agricultural Experiment Station at Cornell University began tests in 1945 with a flame cultivator manufactured by the Graham-Paige Motors Corp., on corn, soybeans, peas, green beans, cabbage and spinach. Weeds up to at least 3 or 4 in high were killed in row corn 6 in high or higher, without seriously damaging the corn. Many large weeds, although not killed, were arrested in growth because of injury by burning. These experiments also indicated that it would seem entirely possible to flame cultivate centers of rows or middles as well as the row itself*.

In 1946 Cornell set up a three-way test on weed control using flaming, chemicals, cultivation, and any other means available. A single burner, hand-operated flame gun, consigned by Hauck Mfg. Co., and a four-burner, gas-burning, tractor-mounted model consigned by the New Holland Machine Co., were used. The general observations at the time of Wright's report in December, 1946, were to the effect that weeds 3 or 4 in high could be successfully killed in field corn, sweet corn, set onions, seed onions over 12 in high, potatoes, lima beans, and deciduous stock with stems of ¼ in diameter or larger*.

Fair possibilities were shown for flame cultivation in green beans, tomatoes, beets, cabbage, cauliflower, and Brussels sprouts. Pre-emergence flaming was recommended for possible effective weed control for almost the entire growing season. A most significant statement is made in Wright's report to the effect that "one possible advantage of flame cultivation over standard cultivation for a long time plan of weed control is that weeds are eliminated from the row; therefore, they are not present with mature seeds at harvest time to be scattered or harvested with the crop to find their way back on the land in manure or in re-seeding for the next crop."

The control of weeds and grasses in cotton by flaming has been adequately discussed in Circular 118 of the Mississippi Agricultural Experiment Station, dated March, 1944. The publication was issued under the late Director Clarence Dorman and written by Dr. J. Winston Neely and Sidney G. Brain. This pamphlet points out that the future prosperity, if not actual conduct, of the cotton industry quite largely depends upon mechanization of production. The circular points out also that one of the most important operations to be mechanized is that of chopping and hand hoeing (cultivating), both of which can be done by flame. The results of various tests showed that cultivation with no hoeing and no flaming yielded 1506 lb of seed cotton per acre, but with no hoeing and with flaming, the yield was 2130 lb of seed cotton per acre.

Neely and Brain found that results obtained would indicate that flaming of the cotton plant 6 in or taller (later changed to specify the stems of the plant as 3/16 in diameter) would satisfactorily control weeds and grasses without affecting yield.

H. T. Barr of Louisiana Agricultural Experiment Station reported in April, 1947, that Johnson grass growing in sugar cane could be controlled to a fair degree by starting on the grass when it is 2 to 5 in high. He further states, however, that if the Johnson grass is 12 to 18 in tall and sugar cane is about the same size or slightly taller, the severe burning to control grass will retard and damage the cane.

"In one series of tests on nine cuts with a corresponding number of check cuts, the average sugar cane yield was one ton per acre higher on the flame plots as compared to that on the hand-hoed check plots. The number of stalks per 100 ft of row, Brix, sucrose and purity were almost exactly the same when comparing flaming against hand hoeing. In this series of tests the burners were set to hit the ground at the base of the sugar cane and the rate of travel was maintained very close to 2 mph. In other tests in which the set of the burners was not watched and the rate of travel was irregular, the yield was lowered two to three tons of sugar cane per acre."†

Barr's report lists the following grasses as subject to successful control by flame: Sheep foot, wild parsley, indigo, crab grass, tievines, cocklebur, nut grass, water grass. A three-row "Sizz-Weeder" is now in use on one of the largest sugar plantations of Florida. There hand-hoeing costs were between $7 and $8 per acre, but weeding costs have dropped now to 50 c and even lower in some instances, by use of the flame cultivator. This particular operator plans to use flame in ramie, a crop gaining increased attention in the Gulf States area.

No publications are available on the flaming of either soybeans or sugar beets, though both practices have been proven successful. Beans as small as 8 in in height have been flamed without injury and constant cultivation from 10 in up ob-

*Wright, Forrest B. Progress report on experiments with flame cultivation at N. Y. Agrl. Exp. Sta. Mimeo 340, Dec., 1946.

†Barr, Harold T. Flame Cultivation, La. Agr. Exp. Sta. Bul. No. 415.

Left: This view shows five flame cultivators moving down the rows, each machine covering approximately 30 acres per day while cultivating the middles in the same operation • *Right:* In this view the fueling operation is being handled from a portable tank and jeep setup in the field. This operation has proven to be a real timesaver in large setups where more than two or three machines are used

served. The conventional method of planting sugar beets is two rows, about 6 in apart, on a single bed. This necessitated placing the skid in the middle and burning one row per bed at a time. Recent information from California indicates that with proper spacing, sugar yield per acre is not reduced by planting one row per bed. This will expedite crop covered per flaming operation, since conventional practices could be followed.

DESCRIPTION OF FLAME CULTIVATOR

The extensive success of present and future use of flame cultivating rests in the efficiency and operation of the flame cultivator as a farm machine. A flame cultivator could easily be described as a strong framework mounted on the rear of a tractor, supporting a fuel tank, with drawbar attached to the frame and skids carrying burners extending back from this and resting in the crop middles. Fuel is fed through tubes from tank to vaporizer and thence to the burner. From this simple setup can be worked out the added features that distinguish one flame cultivator from another. The following parts are necessary in its general performance:

Vaporizers. Recently most flame cultivators have been made to use liquefied petroleum gas such as butane and propane or a blended mix of these two fuels. Since these gases are liquid and under pressure, they must be changed into a vapor to be burned with control and safety features.

For a number of years the problem of vaporizing this gas has been worked at from all angles and to date, no very satisfactory solution has been found. However, some show promise. In the first place, since the flame cultivator is an agricultural implement used in the field it must of necessity carry its vaporizer. With an open flame this cannot be done; therefore, other sources of heat for vaporization must be had, such as the cooling water from the tractor or the exhaust. Both have been used and at the present time, the hot water type is the most successful, since it can be used with all types of liquefied petroleum fuels and will furnish sufficient vapors to handle four-row machines, even with double burners.

Burners. There are two types of liquefied petroleum burners presently being used in flame cultivators—liquid-type and vapor-type burners. Each has advantages and disadvantages.

The liquid-type burner is by far the more complicated in construction and expensive to manufacture. Its design must be such as to eliminate sharp corners. The reason for building along smooth, curved lines is to eliminate any weak points, since these burners must carry pressures up to 40 psi. The burner receives liquid from the tank and the heat of its own flame will vaporize the liquid fuel and permit the vapors to be burned. Otherwise the liquid or raw gas, when ignited, will burn as a wild and uncontrolled flame. The liquid burner, acting as its own vaporizer, eliminates from the machine this added cost. However, cost of construction of the liquid-type burner might more than offset the cost of vaporizers such as the water-cooled type.

The vapor-type burner is strictly just that. It receives the gas which it burns from one of the several types of vaporizers. The liquid is drawn from the tank under pressure, and as it passes through the vaporizer is converted into gas. This, in turn, is piped directly to the burner and consumed as a gas. This type of burner can be one of several, all of which include a burner shell, a spud or orifice, and some means of mixing the oxygen-laden air and fuel that feeds the burner. The particular design of burner will necessarily affect the efficiency of the burner. However, those now being used in flame cultivators are not as efficient as they should or eventually can be. The burner is the heart of the flame cultivator, just as the engine is the heart of a tractor. The other parts are all important, but in its general make-up the burner is the determining factor in the efficiency of the flame cultivator as a field machine.

Field tests have been conducted to determine if more weeds and grasses could be killed with double burners than with single burners. These studies also involved tractor speeds. It was concluded that the single burner operating at 40 psi pressure and moved at a tractor speed of approximately 3½ mph, second gear, was just as efficient as double burners moved at approximately 4½ mph, third gear tractor speed, and operating at 40 psi pressure. The double burners consumed twice the fuel of the single burners and this added cost more than offset the difference in speed. The time element differential involved in filling the two is also a very important factor.

Double burners at 40 psi pressure and moved at 4½ mph showed some damage to small (under 12 in) cotton plants in that it strictured the stem, causing the plant to fall over and making harvesting difficult. No difference was noted in yields. This stricture damage might occur in other crops; only future field tests will prove or disprove that. It would be a fair statement, at the present time, to say that double burners will, no doubt, destroy large numbers of weeds and grasses, but damage from their use should be expected in so far as experience in cotton has demonstrated. If a crop is already lost to weeds and grasses, then use double burners. There will be seasons when rain in the southern portion of the cotton belt will necessitate such drastic steps being taken to combat weeds and grasses.

OPERATING PRESSURES AND TRACTOR SPEEDS

If the machine is used strictly for the control of weeds and grasses in the crop row, care must be exercised as to what size the plant should be to withstand the intense heat. For such crops as corn, cotton, soybeans, sorghum and the like, plants should be large enough to permit the flame to scorch the ground along with young weeds and grasses, but not strike the buds or tender parts of crop. Lower leaves and limbs will be burned at this time, though no material damage will occur.

The operating pressure until these crops are at least 10 in high should not exceed 25 to 30 psi and the tractor speed should be approximately 2½ mph, or low gear. After this, the pressure can be increased to 40 psi and the tractor speed increased to between 3½ and 4½ mph.

As the flame cultivator becomes more widely used in other crops, pressure and speed limits will be determined for them. The use of this type of farm implement is very broad and becoming more so each season. Every crop and every section will present problems which will require much actual field work to find the answers. At the present time, there are some 25 different experiment stations and other agencies working on these problems.

The work of the stations and agencies must continue. The wide-spread use and benefit to be derived from the flame cultivator and flame cultivation will be in direct proportion to the educational program projected prior to, and along with, distribution of machines. That need for education is not limited to the field of adult extension. It begins in the schools and colleges of the nation. No farm machine is a miracle worker, and certainly the flame cultivator is no exception. Modern machines call for modern techniques. These in turn call for skill, training, and thought. The last point cannot be emphasized too greatly. Know how and common sense can double the value of any new equipment.

Knowing is the first task; teaching is the second; follow-up in practice is the third. The Yazoo-Mississippi Delta of the State of Mississippi has more operating flame cultivators per acre, at the present time, than any other section of this country. The machines are working, doing a good job, getting results, because the farmers of that area, through organization, have established, nurtured, and used research; and have developed technological know how. The men of research, in turn, have not held themselves aloof from the practical problems of farm operation. A coordinated program between land and laboratory has developed greater ease in farm operations, created an efficiency in cotton farming hitherto unknown, and has resulted in a higher per capita net return per acre, and a new frontier in agriculture.

This new frontier in agriculture presents to the agricultural engineer greater opportunity for professional service. Far more important is the fact that here is presented the opportunity for a single group of men to play the important role in an economic evolution that means better living and more satisfactory lives for thousands of people. Agricultural engineering now belongs to the farm lands of the nation and the lands of this country are, in part, the stewardship of this profession.

A New Dust Feed Mechanism for Crop Dusters

By A. H. Glaves
MEMBER A.S.A.E.

IRREGULAR performance of crop dusters has been observed in the field repeatedly for many years. During the last ten years application requirements for dusts have probably been under more searching investigation by entomologists and plant pathologists than in any similar period. As knowledge in this field has grown, the requirements in machine performance have become more exacting. These and other factors led to the development of facilities for testing dust materials and performance characteristics of multiple-outlet crop dusters. Special equipment and techniques were developed by the division of agricultural engineering, Bureau of Plant Industry, Soils and Agricultural Engineering, U. S. Department of Agriculture, at Toledo, Ohio, and these facilities have been serving manufacturers of dust materials and crop dusting machines since 1940. The equipment and the test technique for the determination of feed rate and dust distribution performance of dusters were described in 1943[1].

Some feed-rate and dust-distribution performance data on four representative multiple-outlet dusters were reported in this paper in which it was stated that "Unreliable feed-rate control is one of the greatest faults of commercial dusters and should be given primary consideration for improvement." This general characteristic of multiple-outlet dusters was a major obstacle to further testing because variations in dust feed rate were generally accompanied by variations in both distribution[2] and fractionation[3] within the machine.

Eight duster manufacturers have supplied one or more dusters each and have sent engineers and other representatives to the Toledo laboratory in connection with duster testing. A larger number of manufacturers of dust diluents and other dust ingredients have cooperated by supplying regular and specially processed materials and corresponding physical data. With this cooperation hundreds of tests were made with a large number of dust materials in regular commercial dusters and their experimental modifications. Dust feeders used for non-agricultural purposes were studied and some tested. Experimental dust feeders of various types were constructed and tested. Prior to 1942 none of these proved satisfactory for all dust materials. Performance characteristics of a wide range of dust materials were observed as they responded to the action of feed mechanisms in the unmodified commercial machines. These observations were studied along with data on characteristic particle shape, particle size, size distribution, and volume weight of various dust materials. The wide range in some of these physical characteristics is indicated by some physical measurements made on different dusts[4].

The varied responses of different dusts to the action of ordinary feed mechanisms are due to various combinations of such physical characteristics as particle size, particle shape, and volume weight. Representative particle size, as determined with a microscope, ranged from 1.7 microns (calcium arsenate) to 31.5 microns (a pyrophyllite) for a list of approximately 50 materials. The volume weight ranged from 9 to 96 lb per cu ft. A large number of these materials were fed through a regular commercial duster with the same dust port adjustment and the feed rate varied from 0.85 to 31.23 lb per min. The wide ranges in these physical characteristics of dusts partially indicate the versatility demanded of a feed mechanism to be broadly adapted.

The large number of tests with various commercial dusters and many dust materials from 1940 to 1943 supplied a substantial background for the further development of an improved feed mechanism. The many tests made with commercial dusters had shown that none were available at that time which met the exacting requirements for satisfactorily accurate field comparisons of pesticide dusts. For this purpose a machine was needed which could be depended upon to handle dusts with a wide range of physical characteristics with greater accuracy than necessary for general agricultural use. It should be designed for calibrations showing no deviations greater than 5 per cent from a specified dust delivery rate. The dust-feed adjustment should be equipped for positive replication of any predetermined setting.

Accurate control of dust-feed rate has remained a top ranking problem with both users of dusts and manufacturers of dusters. The primary and most urgent need for improved crop dusting equipment was to implement field experiments of research workers in both insect-pest and plant-disease control. Also, and secondary to this, improved equipment was needed to meet somewhat less exacting requirements for general use in order to increase the effectiveness and economy of use of pesticide dusts.

Agitator and dust port design in the regular commercial machines followed no generally common design but varied widely. The variously shaped hoppers were equipped with one, two, or three agitator units: reciprocating, oscillating, rotating, or some combination of these. Peripheral speed of the agitator past the dust port ranged from approximately 15 to 6600 fpm at normal operating speeds. All dusters tested had just one common characteristic — the dust port was at the bottom of the hopper. Only two models had a numbered index for the dust-feed setting.

From an analysis of causes of irregularities in dust delivery of the various dusters tested, it appeared that they were due to one or more of the following factors:

1 Variations in the condition of the dust as put into the hopper.

2 Change in "head" of dust above the dust port as dust was fed out.

3 Change in the fluidity of the air and dust mixture in the hopper due to (a) incorpora-

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[1] A Laboratory Study of Crop Duster Problems, by Frank Irons. Agr. Eng., vol. 24, no. 11, November, 1943.

[2] The term "machine distribution" as applied to multiple-outlet dusters is used to indicate the relative equality of output of dust through each outlet or nozzle.

[3] The term "fractionation" indicates partial mechanical separation of materials within the machine which may result in different concentrations of the active insecticidal or fungicidal agent delivered at different nozzles.

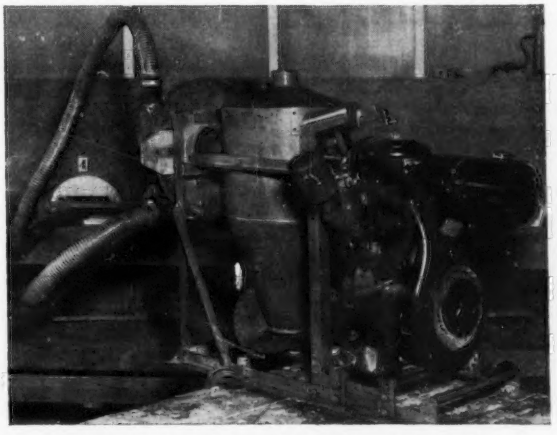

Fig. 1 A general view of the 1946 four-outlet duster unit which is equipped with the VTI (vertical tube and impeller) type of dust-feed mechanism

[4] Specifications of Some of the Ingredients Commonly Used in Fungicidal Dust Mixtures, by J. D. Wilson and Frank Irons. Reported in Ohio Agri. Exp. Sta. Bimonthly Bulletin, vol. XXVII, no. 214, January-February, 1942.

tion of additional air or (b) to decreasing amount of entrapped air by vibration without adequate agitation.

4 Bridging of dust in the hopper (generally most serious with dusts that were fluffy, fibrous, or very fine).

5 Lack of positive control of the dust port opening due to (a) backlash or looseness of connections in control parts, (b) lack of a positive stop, (c) inaccuracy of stop settings, or (d) flexibility between the stop adjustment and the dust port slide or corresponding part.

With this background of experience and information, certain tentative specifications were selected for the development of a dust-feed mechanism suitably accurate for field experiments. These were:

1 It should quickly condition or fluidize the dust to a degree which will be maintained while feeding out at least 75 per cent of the hopper capacity.

2 It should maintain a constant "head" of fluidized dust at the dust port.

3 The adjustment of the dust-port opening should be positive.

4 The dust-feed rate should be adjustable in very fine increments and provided with an index for calibrating and positive replication of any desired settings.

5 It should be capable of handling dust materials with a wide range of physical properties.

6 It should be rugged enough to be dependable and free from trouble due to wear from abrasive dusts in order to insure uniform performance throughout the season.

7 With a given feed setting and a given dust the feed-rate deviation should be no more than 5 per cent above or below the average feed rate for about 75 per cent of the hopper capacity.

8 It should be designed for completely and quickly emptying the dust hopper in order to apply different dusts to experimental plots in rapid succession.

9 It should not generate enough heat to be objectionable with any dust material.

10 It should be as simple as possible in construction, and, if possible, its principle should be adaptable to use in the design of commercial dusters for general agricultural use.

The feed mechanism which most completely met these requirements resulted from gradual developments during 1942 and 1943 and refinements made since then. Dust-delivery performance was determined by taking dust-weight readings for each 30-sec period with continuous delivery. In order to make readings rapidly a dial scale was used and was read to the nearest 0.01 lb. Perforance data taken in this manner were the final basis for selection but were supplemented by concurrent observations on the degree of fluidization of various dust materials and the uniformity of dust circulation within the hopper.

When one of the preliminary models, consisting only of dust hopper and feed mechanism, showed a performance with a maximum deviation of less than 4 per cent and an average deviation of less than 2 per cent with one of the most difficult dust materials, the design was incorporated in a complete duster unit. This machine was used at Toledo, Ohio, in cooperation with the USDA Bureau of Entomology and Plant Quarantine in field experiments for European corn borer control in 1945 and also in 1946. A second complete duster unit was built for additional use in 1946 and is the one shown in the accompanying illustrations. In cooperation with the Ohio Agricultural Experiment Station, it was used at Wooster, Ohio, during the season of 1946 in seven major experiments involving dust application on potatoes, tomatoes, and other truck crops. There were approximately 70 different dust treatments which required 55 feed-rate calibrations in the laboratory. For dusts which were to be applied at the rate of 50 lb per acre, the feed rate calibrations were held within 0.05 lb per min of the calculated requirements of 1.11 lb per min. This would assure that, where the desired application rate was 50 lb per acre, at the specified ground speed the machine would deliver between 47.75 and 52.25 lb per acre. And similarly, where the desired application rate was 25 lb per acre, the machine could be expected to apply more than 24 lb and less than 26 lb per acre. This duster unit is shown in Fig. 1.

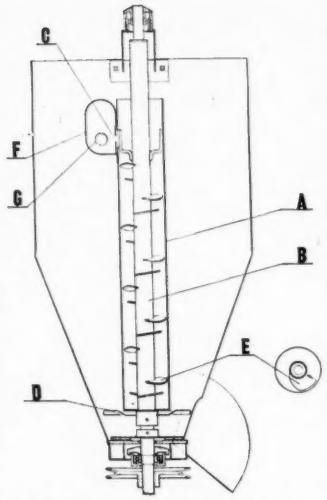

Fig. 2 A cross section through the hopper and vertical impeller tube, showing the relative position of the vertical tube A, the impeller unit B, and the dust port C. The pair of dual-pitched impeller blades are shown at D. The shape of an individual elevator blade is shown in the plan view at the right and indicated by E. As the dust is fed through the dust port C, it is delivered to the fan through the dust delivery tube F which also surrounds the fan shaft G.

The dust feed mechanism consists essentially of only three units: (1) A stationary vertical tube in the dust hopper, (2) a single impeller unit which is the only moving part, and (3) a dust port which is positively adjustable. It has a dust hopper which is cylindrical in the upper half and cone-shaped in the lower half of its height. This is shown in cross section in Fig. 2.

Centrally located in this hopper is a 3-in vertical tube A, with both ends open and its lower end 2 in above the bottom of the hopper. It has a single vertical agitator or impeller unit B, extending through the 3-in vertical tube. Just below the lower end of this elevator tube the impeller carries a pair of blades which drive the dust downward at their tips and, inside of a 3-in circle, they drive the dust upward into the 3-in tube. The pitch of these blades is 10 deg both inside and outside of the 3-in diameter but in opposite di- *(Continued on page 555)*

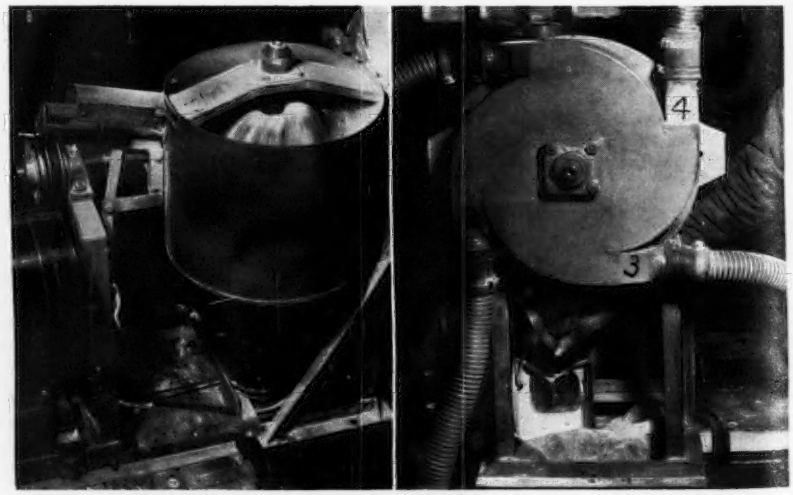

Fig. 3 *(Left)* This view shows the dust overflowing from the top of the impeller tube, the dust feed adjustment, and the numbered index for replicated settings • Fig. 4 *(Right)* A 3-in outlet covered by a felt-padded swinging gate at the bottom of the dust hopper makes it possible to empty the fluidized dust quickly and completely.

A Tractor-Operated Furrow Seeder

By John R. Carreker
MEMBER A.S.A.E.

PLANTING small grain and winter legume seed in furrows without prior tillage between cotton rows in the Southeast is a common farm practice with mule equipment. This procedure permits planting the grain to follow row crops at the optimum planting date, even though harvest of the row crop is not completed. But it limits the winter small grain acreage to the row crop fields.

Many farmers sow annual lespedeza in their small grain and often allow it to produce a second-year volunteer crop. This practice is economical, and it supplies legume grazing, hay, or seed crops, as well as a good degree of protection against erosion, and a supply of stubble-mulch residue for soil improvement.

In practice, an increase in lespedeza acreage generally means an increase in livestock on the farm. This is a desirable trend in southeastern agriculture. It also increases the need for more winter grazing crops.

It is entirely practical in the South to graze livestock in winter on oats in cropland fields, and harvest a crop of grain the following spring. It is therefore often desirable to plant oats on lespedeza hay stubble land to increase the acreage of this grain crop.

Furrow planting grain and legume crops without prior tillage in annual lespedeza hay stubble has three definite advantages:

1 Time and expense of land preparation are saved

2 Planting can be accomplished at times of favorable soil moisture in the fall to insure germination of the seed

3 The combination of contour furrowing and undisturbed surface mulch between the furrows is an important factor in soil and water conservation.

The mule seeder has not been suitable for use in the lespedeza stubble principally because of its light weight. There has not been a tractor-operated planter available to do this work, although there is a definite need for one.

Using equipment available on our Station, I attached a small furrow-seeder unit to the cultivator gang on one side of a small cultivating tractor, and succeeded in planting oats in Kobe lespedeza hay stubble and cotton in the fall of 1946. Photographs of this equipment are shown in Figs. 1, 2, 3, and 4.

Oats were successfully planted in a one-acre terrace interval immediately after Kobe lespedeza hay harvest September 12, 1946, with favorable ground moisture. A detail view of the furrow opener used is shown in Fig. 2. The three cultivator feet were spaced 14 in apart, thus covering 42 in per trip across the field.

An adjacent terrace interval of similar sandy loam soil in the Kobe lespedeza hay stubble was prepared for oats by disking to prepare a good seedbed. Oats *(Continued on page 555)*

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

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Fig. 1 *(Upper left)* A combination seeder and fertilizer drill planting oats without prior tillage in Kobe lespedeza hay stubble land • Fig. 2 *(Upper right)* Close-up view of furrow opener on tractor-operated small grain seeder. When soil became hard a double-point, 2-in shovel was substituted for this 6-in sweep • Fig. 3 *(Lower left)* Planting oats after Kobe lespedeza hay harvest September 12, 1946, with a 3-furrow combination seeder and fertilizer distributor without prior tillage. • Fig. 4 *(Lower right)* Seeding oats in furrows between cotton rows, September 27, 1946, with tractor-mounted seeder and fertilizer distributor

Thoughts on Pond Development

By Austin W. Zingg
MEMBER A.S.A.E.

WEBSTER defines a pond as "a body of stagnant water without an outlet, larger than a puddle and smaller than a lake, supplied with water by surface drainage." He also defines a reservoir as "a place where water is collected and kept for use when wanted." To prevent confusion as to what I have in mind when speaking of a pond, I will define it as "a small storage basin created artificially by man to control or utilize the natural resource of surface water from a few acres of land."

Some years ago I had the opportunity of hearing a lecture by Dr. Li of Peiping, China. His talk developed into a description of a mode of life in certain portions of his home country. The particular economy he discussed was an ancient one built around ponds. In brief, the pond supplied water for human use and for irrigation of two rice crops annually. The pond was also employed as a storehouse for the fertility contained in crop residues. Organic matter and fertility stored in the pond was applied periodically to the soil to enrich it for the growing of crops. In addition, fish from the fertilized waters made up the family meat supply. I have no doubt that such a pond had incidental use for recreation and wildlife.

Pond building, with the exceptions of technique and purpose, is not a new thing in the Midwest. Before the drought years of the thirties there were approximately 100,000 ponds in Missouri. Many of them were too shallow to carry through and provide a source of water supply during that period. The drop in water surface on well-designed and constructed ponds was approximately 8 ft during this time. A minimum depth of 8 ft has since been used as a design criterion.

As a result of the drought the former Missouri State Planning Board recommended the construction of 300 large, deep ponds to be distributed throughout the state. This sounded like a large program at the time. Many of these were constructed as a public works project. Their purpose was to provide an emergency source of community water supply for livestock. The building of ponds to a higher standard was also recommended by various state and federal agencies.

The term "standard" pond has, of late years, been applied to ponds which are a minimum of 8 ft deep, fenced, and piped through the pond bank. The numbers of "standard" ponds constructed in the state increased from less than a thousand to more than ten thousand annually during the 10-yr period 1937-46. A total of 48,732 were constructed during the decade. The goal for "standard" ponds in the State of Missouri has been placed at 500,000 by the college of agriculture. While this goal may seem high to those not familiar with the demand, consideration should be given to the fact that over 200,000 ponds of all types have already been constructed. We can expect the rate of pond building to have its "ups and downs" due to variations in public aid and economic trends. Also, we can depend upon climatic variation, which brings cycles of both flood and drought. I will venture the prediction that the next serious drought will result in an era of pond construction which will, by comparison, dwarf our present accomplishments.

There has been a marked tendency during the last two or three years to increase the size of ponds. Prior to this interest, our concept of a desirable pond has been based upon a surface area of ¼ to ½ acre and a drainage area of 5 to 10 acres. Ponds of this magnitude have proved to be adequate for a livestock water supply. The construction of ponds with surface areas of 2 to 5 acres, having depths ranging from 12 to 15 ft, is now common. Subsidy payments have defrayed only a small portion of the cost of these structures. It is somewhat difficult to explain the interest which has developed in ponds of this type, but in the main it appears to center around the lake features of recreation, fish, and wildlife. In not a few instances, waters from them are being piped for household use. Greater numbers of people are also thinking of filtration and treatment to make the water safe for drinking purposes. They are also talking of the possible use of ponds for flood control and supplemental irrigation.

To my way of thinking, the trend toward larger ponds is a desirable one. It insures a more dependable supply and one which can be adapted to more uses. While a small pond in each field gives a desirable distribution of water supply with respect to crop utilization by grazing, it also presents a maintenance problem. The proper maintenance of fences, pond embankments, spillways, and watering devices common to several small ponds on one farm is not a minor item. By pooling or concentrating the construction effort, a greater quantity of storage could often be provided at less cost and the maintenance problem would be lessened. More attention could then be given to the selection of centralized and efficient pond locations and distribution systems therefrom.

Larger ponds adapted to more uses will bring up new problems of design. Relationships of drainage area to pond area, capacity, and depth will have to be revised to meet these use requirements. Drainage areas for ponds in Missouri may range from 20 to 100 acres. They will be used to supply ponds having capacities of perhaps 20 to 40 acre-feet and the depth will possibly range from 12 to 20 ft. Such ponds

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Philadelphia, Pa., June, 1947, as a contribution of the Soil and Water Division.

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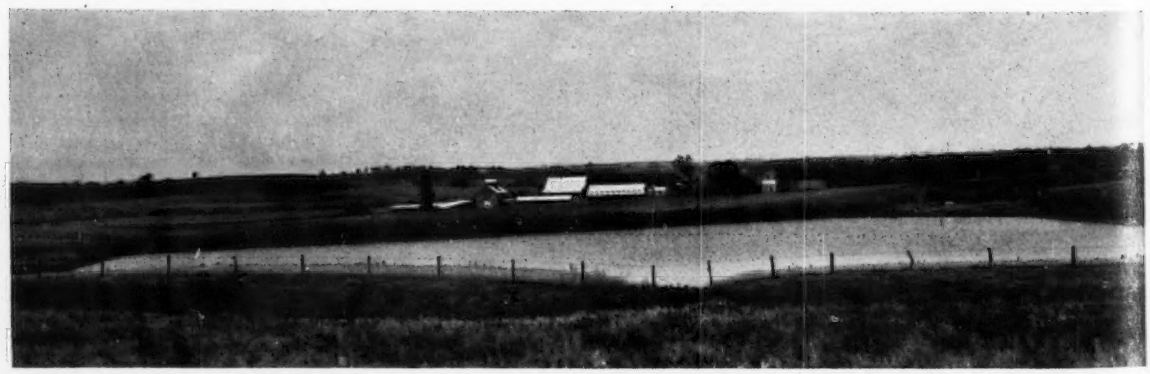

A "retarding" pond in Carroll County, Mo. Drainage area 27 acres; surface area, 3 acres. Temporary storage volume for 1.3 in of runoff is provided for flow retardation and spillway protection. It is depleted automatically by a 4 in steel pipe at a rate of 0.5 cfs. Water for livestock use is piped to several fields and lots below the pond. A supply of "soft" water is also gravity fed to the household

will require a drawn-down device for various purposes. First, some storage space should be assigned to protecting vegetated side spillways. This will also yield incidental local flood abatement. The major portion of storage may also be used for supplemental irrigation and require controlled release and distribution. Household and livestock supply may require yet another type of distribution system. We should be able to clear the pond for repair and possibly to harvest and restock fish. It is again possible that all these controls could be accomplished by the use of one outlet works through the pond embankment.

We know little concerning the potential of supplemental irrigation in the humid agricultural region. Obviously, only a few acres of land could be irrigated from a pond. The application of water alone to crops as they are grown and managed presently would perhaps not be feasible. Certain crops and cultural methods in conjunction with a high level of organic matter and fertility could, however, change the outlook entirely. It is not improbable that one acre could perform the duty of several as they are now employed. This development would represent one of the highest types of conservation, both soil and human.

The projection considered here is a visionary one, yet none of the elements involved in it are new. I am not proposing that we advocate the building of ponds of this nature in the immediate future. What I am proposing is development research to explore thoroughly possibilities and limitations of additional, as well as multiple-purpose uses of our resource of surface water on the farm. The field of water resource development for local beneficial uses remains almost untouched in the humid agricultural region. It is time to abandon the "common enemy approach" to the management of surface waters and devise methods of allying it with our agriculture.

Feed Mechanism for Crop Dusters

(Continued from page 552)

rections. This produces continuous flow downward outside of the tube and upward inside of the tube. One pair and 15 single blades, as indicated by E, at 1-in vertical intervals on the impeller shaft and all inside of the 3-in tube cause continuous and rapid circulation of the dust upward to the top of the tube. The direction of rotation of the impeller is clockwise as viewed from above. The overflow of dust from the top of the tube carries air downward into the dust mass to produce the fluidizing effect as it is recirculated continuously.

Fig. 3 shows the dust overflowing from the top of the impeller tube. With any given dust this air-dust mixture in the hopper reaches a fluidized condition at which it remains nearly constant because the rate of air escape equals the rate of entrapment.

An inch above the upper impeller blade there are two feeder arms which are in register with a vertical dust port slot (⅛x1 in). The escape of dust through this dust port is regulated by a sheet metal slide having a narrow V-shaped slot C (Fig. 2) and controlled by an indexed screw adjustment. The dust is drawn from the dust port at C into the fan through the horizontal tube F about the fan shaft G. On-and-off control of the dust is accomplished by the use of a second sheet metal slide not shown but located in the same channel as the V-slot slide used to regulate dust-feed rate. The horizontal dust delivery tube F tapers to a circular section as it approaches the fan. The delivery end of the tube F is 2 in in diameter and concentric with the fan shaft. Additional air intake in the fan case is 5 in in diameter and also concentric with the fan shaft. This is shown in Fig. 1.

The facility with which the dust hopper can be emptied also deserves special mention. By opening a swinging dust gate at the bottom of the hopper when the machine is running at full speed, the dust will flow from the hopper as though it were a liquid. Fig. 4 shows the dust being rebagged. With most dusts this emptying is so complete that there will be less than one ounce of dust left in the hopper. This feature is imperative in a machine which is to use different dusts alternately. It need not increase the cost appreciably in a commercial machine and eventually it should become a standard feature in machines for general agricultural use.

The exact power requirement for driving the feed mechanism has not been determined. The fact that a ⅓-hp motor was adequate in all of the development trials, even with the heavier dusts and impeller speeds up to 2500 rpm, indicates that the power requirement is very low. An impeller speed of 1500 to 1600 rpm has been found suitable for the usual range of pesticide dust materials. This will give a peripheral speed of approximately 1150 fpm for the feeder arms and with most dusts the amount of heat generation with continuous operation will not be objectionable. The power requirement is undoubtedly lower than for the agitators of several of the commercial machines.

The four-outlet duster unit shown in the accompanying illustrations has a hopper capacity of 1 to 1¼ cu ft of dust, can deliver up to 220 cu ft of air per minute per nozzle, and weighs 132 lb without the engine.

Tractor-Operated Furrow Seeder

(Continued from page 553)

were drilled 14 days later at the same seeding and fertilizer rate used with the furrow seeder. This delay of 14 days in planting was necessary because the soil was too dry for planting after it was disked.

This tractor-operated furrow planter was also used to plant oats, vetch, and Austrian peas between cotton rows on the Station plots and terrace interval rotation studies. A front view of the equipment operating in cotton on September 27 is shown in Fig. 4. Practically no damage was done to the cotton by operating this machine following the first picking.

Yields of oats and Austrian peas in the various fields where this planter was used are given in Table 1. The first two yields listed on Class II land were hand-harvested with hoops (small 1/2000-acre sample areas), whereas the other three were amounts actually threshed through the combine. Hoop yields are normally about 15 to 20 per cent higher than the combine-harvested turnout from the same field. Differences in fertilizer and land capability were other factors in these yield variations.

In general, our field results from the use of this machine were as satisfactory as with conventional small grain seeders. However, this rig as used had several defects that should be remedied. The draft rod between the shank bar and front axle housing was weak for the job to be done. The location of the seed box interferred with the operator's vision. Coulters were needed in front of the feet to prevent clogging in spots of Bermuda grass sod. The rear wheel compressed soil in one of the furrows. Some difficulty was had with the spouts stopping up with soil in the outlet.

Only one year's results are reported in this paper, but they indicate that a tractor-operated furrow seeder has a definite place for seeding small grains and winter legumes in conservation-type rotations which are coming into extensive use in the Southeast.

TABLE 1. YIELDS OF OATS AND AUSTRIAN PEAS PLANTED WITH A FURROW PLANTER WITHOUT PRIOR TILLAGE AND WITH A CONVENTIONAL GRAIN DRILL ON A DISK HARROWED SEEDBED

Crop	Type of planter	Preceding crop	Fertilizer at planting lb/acre	Fertilizer at planting N-P_2O_5-K_2O	Planting date	Land class	Yield per acre	Remarks
Oats	furrow	Kobe lespedeza hay	350	4-10-4	9/12/46	II	76.4 bu	hoop basis
Oats	disc and drill	Kobe lespedeza hay	350	4-10-4	9/12/46	II	76.0 bu	field basis
Oats	disc and drill	corn	300	0-14-10	10/18/46	III	37.0 bu	hoop basis
Oats	furrow	cotton	200	0-14-10	9/27/46	III	31.8 bu	field basis
Oats	furrow	cotton	200	0-14-10	9/27/46	IV	26.7 bu	field basis
Austrian Peas	furrow	cotton	200	0-14-10	9/27/46	III	12 tons	green weight, hoop basis

NOTE: All oats received a top-dressing of 140 lb 12-0-4 fertilizer per acre in March, 1947.

Electric Milk Pasteurizers for Farm Dairies

By J. P. Schaenzer and Sam Shiozawa
FELLOW A.S.A.E. MEMBER A.S.A.E.

NO RAW milk can be guaranteed as safe, but according to health authorities, proper pasteurization of milk can and does prevent the transmission of all milk-borne diseases. Since these diseases can be prevented and the economic losses avoided through proper pasteurization, the Rural Electrification Administration has stressed for the past several years the development of pasteurization equipment suited for use in the farm home and by the small milk retailer. Definite progress has been made. Manufacturers, researchers, and others have participated and much credit is due all of them. Several small milk pasteurizers are now on the market and others will be in the near future. Still others are in the model or experimental stage.

Before examining specific units, it might be well to review briefly the history of pasteurization and define the process. As commonly thought, the process of milk pasteurization did not originate with Louis Pasteur. He did, however, introduce the method and used it for heating beer and wine so as to prevent souring. In 1873 Jacobi of New York City recommended that milk for infant feeding be boiled in the bottles. As far as is known, he was the first to advocate the heating of cow's milk. Twenty years later (1893), Nathan Straus, New York City, was the first to sell sterilized milk. Many others soon followed suit. Continuous-flow, milk-heating equipment was developed between 1890 and 1905 using temperatures from 158 to 165 F. This was not too satisfactory as controls were inaccurate and holding times indefinite. In 1906, Rosenau found that he could destroy the most heat-resistant, milk-borne pathogen at 140 F in 20 min. Because of his work and the corroboration of it by other investigators, low-temperature pasteurization was generally accepted by health authorities. Great improvements were made in the commercial equipment because of the development of controls and safety devices. These improvements led to the acceptance of high-temperature, short-time pasteurization by health authorities. These two methods are defined by the Milk Ordinance and Code as follows: "Pasteurization is the heating of every particle of milk or milk product to at least 143 F and holding at this temperature for at least 30 min, or to at least 160 F and holding for at least 15 sec, in approved and properly operated equipment."

Pasteurized milk is available in most of the larger communities. In 1936 the U. S. Public Health Service reported pasteurized milk available in 42 per cent of the communities having a population of 1000 to 2,500, with 24.5 per cent of the milk pasteurized. Undoubtedly there was a lesser percentage of pasteurized milk available and used in the still smaller communities, and most milk producers used raw milk. For these smaller communities and individuals pasteurization equipment, which is low in initial cost, yet effective, must be provided. What has been done to meet this need?

MILK PASTEURIZATION FOR SMALL RETAILERS

Resistance-Type Batch Pasteurizer. Research work was begun in 1931 on a 12-gal electric resistance-type batch pasteurizer by the National Rural Electric Project in cooperation with the University of Maryland. Results of these investigations were published in two progress reports by H. E. Besley and A. V. Krewatch, respectively, who carried on this research. This project was abandoned in 1933 and reopened in 1937 by Maryland Agricultural Experiment Station, with G. J. Burkhardt, C. W. England, and A. P. Wiedemer continuing the work.

The steel vat of the model pasteurizer is lined with synthetic rubber. The inside dimensions are about 24x13½x10½ in. The two electrodes are of graphitized carbon, ¾x12x10 in and hook over the rim of the vat. The resistance of milk to the flow of alternating electric current is used as the heating means. It operates on 230 v, and the maximum current demand is 31 amp.

A milk agitator mounted on the cover is driven by a small electric motor located under the vat. A mercury column thermostat is used which accurately regulates the temperature of the milk within ½ F.

When the milk reaches 143 F, a self-starting electric clock is started by means of a sensitive control relay and continues to run for 30 min. An alarm signals the end of pasteurization.

Safety features are embodied in the design to prevent accidental electric shock to the operator. When the cover is lifted, the circuit is automatically broken. The drain is located at the neutral point of the 220-v circuit so that contact with the milk leaking or flowing from the drain while the current is on will not cause shock. A heavy ground is supplied.

For a 12-gal batch the total amount of energy used ranged from 0.3 kw-hr per gal with a starting temperature of 38 F to

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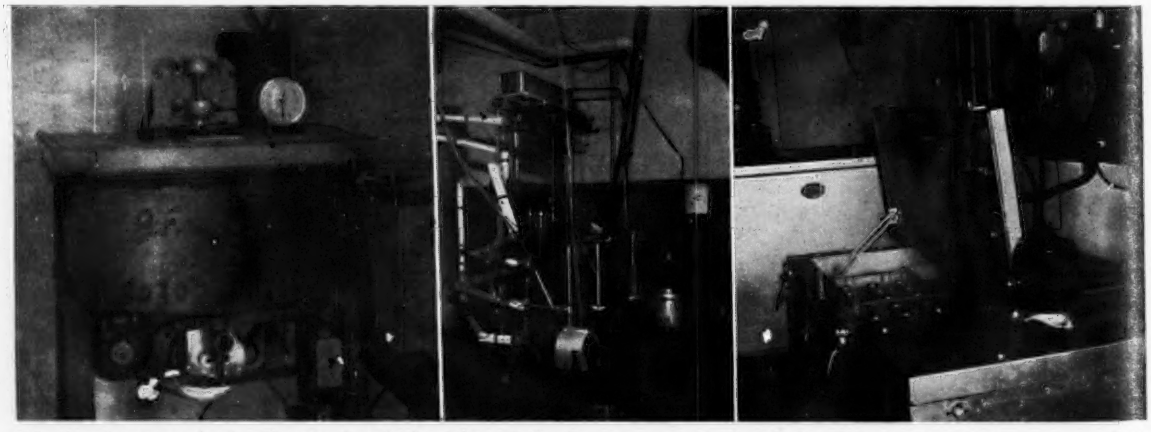

Left: A resistance-type batch milk pasteurizer developed by agricultural engineers associated with the National Rural Electric Project and the Maryland Agricultural Experiment Station • *Center:* The high temperature, short-time pasteurizer developed by Maurice W. Nixon • *Right:* The experimental in-the-bottle pasteurizer developed by D. E. Blandy

0.16 kw-hr per gal with a starting temperature of 90 F. Many months of experience with this unit in more or less regular operation indicated that the unit is safe, workable, efficient, and very quiet in operation. Complete details of this unit were published in AGRICULTURAL ENGINEERING for March, 1941.

The Northeastern Engineering Inc., Manchester, N. H., is now building several models of this pasteurizer which will be ready soon for testing by the University of Maryland. Although the fundamental principles of the original pasteurizer have been retained, many refinements have been incorporated in the new model.

A solid porcelain tank is encased in a modernistic cabinet finished in acid-resistant enamel. The agitator and thermostat are built into the cover. The tank slopes to a stainless steel drain valve in the center, and doors in the front allow access for a standard milk can. The splash-proof steel control panel for wall mounting is also finished in acid-resistant enamel. It houses the circuit breakers, relays, and synchronous motor-driven timer. On its front are indicating lights for 220 v power on, for 110 v agitator motor on, and a light or bell to show the end of pasteurization.

Heavy molded rubber cord sets permit interconnection between the wall-control panel and the pasteurizer cabinet. Interlock switches on doors and covers eliminate all electric shock hazard.

High-Temperature, Short-Time Pasteurizer. During the late 1930's Maurice W. Nixon, then stationed at Cornell University, developed an experimental model high-temperature, short-time pasteurizer. It was designed so that all adjustable devices, including temperature regulators and milk and water-flow regulators, could be adjusted, tested, and sealed by the department of health, thereby eliminating all manual adjustments. Except for supplying and removing the milk, the operation of this pasteurizer is entirely automatic.

OPERATION OF NIXON PASTEURIZER

In operation, hot water at about 163 F from an electric water heater is circulated by a pump through booster heaters having a total capacity of 11 kw, through a two-stage tubular milk-cooler unit and returned to the heater. The booster heater maintains the water at 172.5 to 174 F.

The milk is pumped from a milk sump to a supply tank from which it flows by gravity through a heat exchanger where the milk absorbs from 16 to 24 F of heat from the milk already pasteurized. This preheated milk then flows over the hot water tubular surface heater, is heated to 163 F, collected in a trough, and fed into an inverted siphon which serves as a 15-sec holding chamber. After flowing through the heat exchanger, the milk is discharged to be cooled for storage. If the milk does not reach 163 F, it is automatically diverted back to the sump.

The capacity of the pasteurizer, in gallons per hour, is determined by the volume of water available, the temperature drop which may be compensated for in the booster heaters, and the temperature of the raw milk. With an 82-gal water heater, the hot water flowing at the rate of 7 to 8 gal per min, and the booster compensating for a temperature drop of 11.7 F, the capacity was 23 gal per hr of 45 F milk and 60 gal per hr of 82 F milk. The electric energy consumption for this unit ranged from ⅓ to slightly over ½ kw-hr per gal of milk pasteurized plus stand-by water heater losses. This pasteurizer is described in detail in AGRICULTURAL ENGINEERING for July, 1941.

Although this small unit has not been developed further for commercial production, definite possibilities lie in this method of pasteurization. Mr. Nixon showed that a high-temperature, short-time pasteurizer can be built at a nominal cost and operated successfully.

In-the-Bottle Pasteurizer. Two experimental in-the-bottle pasteurizers were developed prior to 1941 by D. E. Blandy, at that time with New York Power and Light Corp. Their capacities were 4 cases or 48 qt and 8 cases or 96 qt.

AGRICULTURAL ENGINEERING for July, 1941, contains the following statement on this unit:

> "The principle involved in this method consists of transferring heat as quickly as possible from a body of water held at 145 F to the bottled raw milk. The bottled milk is held in the vat an hour and then cooled, still bottled.
>
> "The equipment consists of a hot water tank with water pump, immersion-type electric heaters and the necessary thermostats to control the temperature of the water bath, an indicating and a recording thermometer, and racks to support the bottle cases. It was necessary to use a new thin-wall, oversize glass milk bottle. Convection currents are set up in this bottle, making heating about twice as rapid as in the standard bottle. Bottle caps with paper inserts seal the bottle.
>
> "The heating period of about one-half hour is followed by a half-hour holding period, both of which are recorded on a graphic thermometer chart. After the milk has been held, the pump is stopped and the vat opened to remove the bottles in the wire crates. These are set in the air for five minutes or so, after which they are immersed in a cold circulating water bath and cooled to the desired temperature for storage. A milk cooler tank with special platform and pump was used for this purpose."

It is reported that this pasteurizer was manufactured by Emil Steinhorst and Sons, Utica, N. Y. Production ceased because of the war but it is believed by interested parties that production will be resumed at an early date.

Batch Pasteurizers. Prior to the war, Oakes & Burger Co., Inc., Cattaraugus, N. Y., built experimental batch pasteurizers of 10, 20, and 30-gal capacity. The war interferred with the further development and quantity production of this equipment. In addition to the previously mentioned sizes, consideration is now being given to a unit of 5-gal capacity or less and perhaps a 15-gal size.

The round milk container of this pasteurizer is constructed of 20-gage stainless steel with all joints welded and polished. It is surrounded with a water jacket constructed of plate steel with the inner surface treated to retard rust. The height and diameter of the pasteurizer vary with the capacity. It is insulated with asbestos sheeting covered with light-gage galvanized steel. The cover is made of stainless steel with openings for the indicating and recording thermometers. It also has an opening to accommodate a standard milk can strainer which has its own cover, eliminating the need of removing the complete cover while filling. An agitator, which is removable for cleaning, is mounted on top of the tank and is operated by a 1/30 hp, 110-v, a-c, 60-cycle motor.

Water at 160 F is supplied by an electric water heater. The size depends upon the capacity of the pasteurizer. A water-circulating pump driven by a 1/30-hp, 110-v, a-c, 60-cycle motor, circulates the hot water through the water jacket of the pasteurizer.

When the milk reaches 143 F, the hot water motor stops, shutting off further circulation, and a thermostat operates a solenoid valve, permitting the hot water to run out of the water jacket. This prevents further heating and it is claimed that the pasteurization temperature is maintained for 30 min.

It is reported that a 20-gal pasteurizer installed on the farm of Edward H. Hickman, Eden, N. Y., has given complete satisfaction. He generally pasteurizes twice a day. The equipment is so arranged that after the milk is pasteurized he circulates cold water from the milk cooler through the water jacket. Average energy consumption is approximately 0.6 kw-hr per gal of milk pasteurized.

REPUBLIC STEEL BATCH PASTEURIZER

Another 10-gal batch pasteurizer was designed and built for use on the experimental farm of Republic Steel Corp., Cleveland, Ohio, by E. D. Anderson and T. E. Long to provide pasteurized milk for the families living on the farm and visitors. After analyzing a number of commercial units of larger size and reviewing the requirements of pasteurization, they designed a pasteurizer to be as simple as possible.

Fundamentally, it is designed around a 10-gal milk can, which serves as a holding vessel throughout the pasteurizing and cooling operation. An outer round jacket for water, which surrounds the milk can, is encased in a cabinet approximately 2x3x3 ft. Holes are provided near the upper edge of the round inner shell through which both hot and cold water are sprayed against the can.

A 6-kw electric immersion heater operating on 230 v, a-c, 60 cycles, is installed in the pasteurizer.

After a can of milk is placed in the pasteurizer, approximately 8 gal of hot water at about 140 F from an electric water heater are poured into the surrounding water jacket. It requires approximately 30 min for the 6-kw heater to bring the milk up to the 143 F pasteurization temperature. A pump, powered by a ⅓-hp motor, circulates the hot water around the can. The agitator, driven by a ¼-hp motor through a gear-reduction drive, and the tube of the recording thermometer are inserted in the milk through holes provided in the special can lid. Smaller motors could be used but were not available. When the 30-min pasteurization process is over a bell rings.

The heating element is turned off manually and the hot water drained. A ⅓-hp motor starts a pump and cold water from a milk cooler is circulated around the can. It requires about 20 min to cool the milk from 143 to 50 F after which the milk is stored in the milk cooler.

No energy studies have been made on this pasteurizer. Changes, such as using smaller and fewer motors and pumps, are being considered. Besides being simple in design and operation, this pasteurizer has a minimum number of parts to wash and sterilize. This is an important factor in a one-man dairy.

Radiant Energy Milk Pasteurizers. Dr. Matthew Luckiesh, director, lighting research laboratory, General Electric Co., Cleveland, Ohio, in his recent book, "Applications of Germicidal, Erythemal, and Infrared Energy," writes as follows regarding the use of germicidal sources in treating highly absorbing liquids:

> "Milk in a very thin layer is highly absorbing. Nevertheless, many years ago experiments were made with quartz mercury arcs in disinfecting very thin films. In one case this film was gathered on the edge of a revolving disk and was wiped off and collected after exposure to ultraviolet energy. Inasmuch as a 30-w germicidal source is nearly as effective in killing microorganisms as a 300-w quartz mercury arc, it is possible that milk might be successfully treated in a device such as that illustrated. Ozone imparts an undesirable taste to the milk. Therefore, the air in the milk or in contact with it might have to be eliminated or at least reduced."

COLD-RAY PASTEURIZER

Cold-ray pasteurization of milk in Germany was reported by C. O. Ball on behalf of U. S. Technical Industrial Intelligence Subcommittee. This pasteurizer is installed in the plant of Hansa Meierei Facherberger Allee, Lubek, which produces evaporated milk and milk powder. The unit consists essentially of a spiral quartz tube, approximately 0.4 in in diameter, said to be 360 ft long, and 8 mercury vapor tubes supplying ultraviolet rays.

The milk tube, coiled to a diameter of about 13 in, is mounted in a horizontal position in a roughly constructed sheet metal cylinder about 24 in in diameter and 70 in long having wooden ends. Four mercury tubes having an outside diameter of about ⅓ in are placed on the inside of the coil, about 5½ in apart, and 4 additional ones on the outside, about 13 in apart. These tubes are about 4 in longer than the coil enclosure so that they can be supported horizontally through holes in the ends.

Connection at each end of the quartz tube milk coil is made by rubber tubing. A rotary pump forces the milk through the coil at the rate of 53 gal per hr and it is exposed for 1¼ min.

An undated progress report by Lembke, Rickert, Thomsen, and Christopherson, Preuszischen Versuchs-und Porschungsanstalt fur Milchwirtschaft, Kiel, makes the following statement in regard to studies of the ultraviolet ray pasteurizer:

> "*Results.* Almost complete sterilization of the milk was attained, whereby the milk would keep approximately 24 hr longer. Both spore-forming proteolytic bacteria and all pathogenic organisms could be positively destroyed. . . . The taste change can be regarded as insignificant. Enrichment with vitamin D proceeds simultaneously."

The results, however, are not to be considered as sufficiently definite and consistent to justify a statement that the efficiency of the ultraviolet method of pasteurization has been proved. A procedure which could be utilized with confidence in pasteurizing milk by this means has not been worked out. The most serious obstacle lies in the failure to provide a means of assuming that every particle of milk is in contact with the walls of the exposed quartz tube for a sufficient length of time to enable the rays to destroy the dangerous micro-organisms contained therein. This objective can be attained by allowing a sufficient length of time to ensure the necessary exposure to all particles of milk, or by increasing the turbulence in the stream of milk while passing through the tubing.

It would seem that a large amount of fundamental work remains to be done in developing a means of providing positive control of the factors discussed.

HOME PASTEURIZERS

Batch Pasteurizers. A home pasteurizer electrically operated is manufactured by Guard-it Mfg. Co., 615 N. Aberdeen St., Chicago, Ill. This unit stands approximately 21 in high and has an outside diameter of about 12 in. It consists of an outer rust-resistant metal water container, equipped with handles and coated with baked enamel, a cover with built-in stainless steel agitator, operated with a solenoid-type motor, and an inner steel, tin hot dipped, two-gallon milk container. A 1250-w, 110-120-v, a-c, 60-cycle immersion-type heater is installed in the base.

When pasteurizing milk, the water tank is filled with 9 qt of water. The timer is set for about 30 min and the unit plugged into an outlet. When the water is heated to a temperature of 145 to 149 F, the thermostat setting, the lower of two lights glows on the control panel. If warm water is used, less time will be required. The pail, containing the milk, is then set in the water bath. This container is held by a strap hanger supported on rubber gaskets. The cover assembly is next put in place and the motor-agitator plugged into the front panel outlet. The time switch is set for one hour. If the milk is below 60 F, an extra 15 min should be allowed for heating the milk. The thermostat automatically turns the heater on and off to maintain the water and milk at the required temperature. When the upper lamp lights, it indicates the end of the pasteurization process.

It is claimed by the manufacturer that the up-and-down action of the agitator not only causes the milk to circulate but this action is also transmitted to the surrounding water bath, thus insuring an even temperature distribution both in the milk and the water.

If a pressure water supply is available, cold water can be circulated around the milk container by means of a hose connection. An overflow is provided. Operation of the agitator for about 20 min will insure still faster cooling. Or the milk container may be removed immediately after pasteurization and placed in a milk cooler for storage. Again, the agitator can be used to speed up the cooling.

Another electric batch pasteurizer is made by Waters Conley Co., Rochester, Minn.

It consists of a base having a 300-w, 110-120-v, a-c, 50 or 60-cycle heating element with thermostat placed in the bottom of a barrel which serves as a housing and flue to distribute the heat around a 1-gal milk bucket. Both housing and bucket are made of drawn aluminum. The housing is coated with baked lacquer. The lid of the bucket overlaps the rim so as to shed water when cooling the pasteurized milk. The thermostat is spring-mounted to insure good contact with the bottom of the bucket. A thermostatically controlled timer does not operate until the milk has been heated to the pasteurization temperature. A buzzer operates when the timer returns to the "off" position.

When pasteurizing milk, the timer knob is turned to the right as far as possible, the unit plugged into an outlet, and the operation is automatic. When the milk reaches the proper temperature, the heater is turned off and the timer starts operating. If the temperature of the milk drops below 143 F, the thermostat turns on the heater and stops the timer until it is again up to temperature. At the end of the 30-min pasteurization period, the current is cut off from the heater and a buzzer sounds until the pasteurizer is disconnected.

With a full gallon of milk at 50 F, approximately 1 hr and 15 min are required to complete a pasteurization cycle. Smaller quantities may be pasteurized, although less than a quart may heat too rapidly.

(Continued on page 562)

Engineering in Soil Conservation

By H. H. Bennett

ENGINEERING is a fundamental part of modern soil conservation. In one way or another it enters into conservation work at almost every step and stage from planning, through application of the plan to the land, right on to the stage of maintenance.

Even before the farmer and the conservationist go over a farm, field by field, acre by acre, to plan for the use and protection of every acre on the farm, a good air photograph is needed as a base map for the soil conservation surveyor, who puts on the map the physical conditions of the land and the use being made of it. This conservation map shows the slope of the land, the soil, degree of erosion as the result of past use, susceptibility to erosion, and location of fields, pastures, woods, gullies, cliffs, swamps, streams, springs, and houses.

These land condition and cultural features are required for the development of a simple land capability map, that shows not more than eight land types. This is the map that the farmer and technician work with in the field developing the farm plan.

Any lack of needed engineering guidance in carrying out these three initial steps leading up to actual application of soil conservation measures to the land will either slow down the work or lower its quality. Consider slope, for example. Generally it is unsafe to use a slope in excess of about 12 per cent for row crops, especially on shallow or highly erodible soil.

In all planning for conservation, engineering principles must be the guide for fixing the dimensions, cross section, location, and often slope limitation for all water-control structures, whether they be terraces, baffles, drop-inlet culverts, or dams for gullies and farm ponds. Not only that but in the case of dams, the water-yield capacity of the particular watershed must be carefully examined for as accurate determination as possible, on the basis of size, slope, soil, and land use.

Even in arriving at a decision as to how much grain stubble or combine straw to plow under and how much to leave on top of the ground, engineering considerations are involved. Here the dynamics of both wind and water are involved and should be given the most careful consideration, making use of both research and conservation experience.

Windbreaks for satisfactory efficiency in controlling snowdrifts, alleviating winter effects of wind about farm buildings, and in wind-stripping must be carefully planned with respect to location, height, shape, and density.

In our experience with the use of strips of vegetation, board, or cement for stabilizing ditches, there has been general failure when the strips were placed intermittently across the bottoms of the channel, particularly where the subsoil consists of friable sand-clay material. Such material, it was found, offers only slight resistance to erosion. We have learned from these failures that such ditches must either be solidly lined with cement or planted continuously to vegetation which offers sufficient resistance to scouring over definite ranges as to grade. Hydraulic tests have been made at field laboratories to determine indices of resistance for a number of grasses and legumes that can be grown under the subsoil conditions of ditch excavations.[1]

Until recently clean plowing has been almost universally used, supposedly as the best way to plow. It is, of course, in many instances. But where all crop stubble or residue is plowed under, the soft, upturned earth is exposed to the full erosive effects of wind and water. Both research and experience have shown that satisfactory soil protection can be provided where part of the stubble of grain or other crop residue is left on top.

It has been found that stubble-mulch farming is highly effective, in reducing soil and water losses in parts of the humid areas, as in South Carolina, during the frequent torrential rains of July and August. It also has a decidedly beneficial effect on soil aggregation, and this, in turn, has a decidedly favorable effect on water infiltration. The practice displays this tendency in most of the areas throughout the country where it has been tried.

Much research work needs to be done in connection with perfecting the stubble-mulch method for the various erosion problem areas of the country. In some localities, for reasons not completely understood as yet, there is a tendency for the practice to reduce yields, particularly for corn.

Agricultural engineering in the development of adaptable implements for such work as cultivation, spraying, and digging potatoes has done much for sound soil conservation. Spraying, cultivating, and digging potatoes on the contour, for example, has required the modification of considerable of the machinery used for these purposes.

Terracing has been greatly improved through the research activities of the soil erosion experiment stations, especially with respect to spacing, grade, cross section, height, type, adaptation to slope, and maintenance. Formerly little attention was devoted to water disposal at the terrace outlet. Now the conservation engineer in developing a permanent terracing system for a farm makes provision always for safe water-disposal outlets. This may be a grass-stabilized outlet, or it may be a piece of woods having a suitable cover of forest litter or a suitable area adequately stabilized with grass, legumes, or shrubbery.

This power reservoir has been rendered useless because of silting. The dam shown in the foreground was built less than twenty years ago

Soil conservation structures involved with rapid movement of water have been subject to considerable hydraulic study with respect to how best to dissipate the increased energy. Such studies have been carried on at the hydraulic laboratory at the California Institute of Technology and the laboratory at St. Anthony Falls, Minnesota. A number of successful designs have been developed for spillways and stilling basins to meet different conditions of water flow. One developed at California Institute of Technology has found its way into practical use in various

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[1] Nutt, G. B. and T. C. Peele, Engineering and Agronomic Phases of Mulch Cultivation. AGRICULTURAL ENGINEERING 28 (9) September, 1947: 391-393.

parts of the West. Since the design of all spillways cannot be standardized, the investigations are continuing. Similar studies are being made with respect to the hydraulics involved in pipe outlets for culverts.

A very important item of research in connection with the handling of water is being carried on at the Coshocton, Ohio, watershed laboratory, and at a number of smaller watershed field stations. One of the objectives of this work is the determination of peak rates of surface runoff; and another is to determine the amount of total runoff from a watershed of given characteristics under use for different agricultural purposes. The data being sought are essential for safe and economical design of a variety of structures involving the use of water. They are also useful in connection with accurate determinations of flood control effects resulting from changes in land use and the installation of effective measures against soil erosion. Heretofore most all streamflow measurements have been made for large watersheds, usually in excess of 100 square miles. Little information has been available on small watersheds in agricultural areas ranging from around 5 to 10 thousand acres. These studies are now being made on a number of strategically located watersheds throughout the country.

Drainage is another activity in connection with soil and water conservation that involves engineering consideration at almost every step from planning to the designing of structures, installation, operation, maintenance, and improvement. Drainage engineers, for example, have for years been collecting runoff data as the basis for estimating the required capacities of main ditches, laterals, and tiles. Early studies of large and small ditches, under conditions ranging from good to all stages of deterioration, were used to determine the retardance coefficient values — n in the Kutter formula — for flow in the channels. This value has generally been accepted as standard and has been of much value. Nevertheless there has been no adequate determination of resistance to flow by various types and densities of vegetation grown in ditches in connection with the determination of n. But, since some determinations have been made of the retardance coefficient for obstructive vegetation in ditches, the values used in designing ditch capacity are much better than formerly.

Much additional hydraulic information is still needed, however, along this line.

Depth and spacing of field drains is still a matter in which experienced judgment is the guide, since no generally dependable means has yet been developed for measuring rates of water percolation through different soils, especially those having dense, plastic clay subsoil. The early trial and error methods, however, are gradually being replaced by more scientific methods coming out of our national program of soil conservation. Laboratory and field tests are yielding helpful information.

For some years drainage engineers have been conducting studies on the peat soils of the Florida Everglades and of the muck lands of northern Indiana, to determine the most economical methods for water level control and the best depths at which to maintain the water table. Peat lands, and to a less extent muck lands, are subject to subsidence following drainage and cultivation. The rate of subsidence for peat is nearly proportional to the depth of drainage, and under these conditions it may be found economical to maintain a relatively high water table in order to conserve the soil — prevent subsidence and burning.

An advantage of underdrains over open ditches for farm drainage is that they do not reduce the cultivable area or interfere with farming operations. Thus underdrains are specially desirable in dense clay soil where the drains must be closely spaced. Under some conditions tile drains may be of prohibitive cost, and open ditches offer too much interference with cultivation. Mole drains—unlined openings made through the subsoil — seem to offer a practical solution if not too susceptible to obstruction by caving. Experimental installations have been made in a number of states, to determine in what land types and under what climatic conditions these will stay open long enough for economical use.

The maintenance of open ditches in effective condition requires removal of growing vegetation and of sediment resulting from erosion of neighboring uplands. Machinery suitable for practical ditch cleaning is much needed.

During the past year a total of more than 1.5 million acres was planned for drainage as part of farm conservation plans made by the Soil Conservation Service in cooperation with soil conservation districts. Farm drainage systems benefitted ¾ million acres. This is twice the acreage planned or drained in any previous year, indicating that this phase of soil and water conservation is becoming more active since the close of the war and the release of more engineers and contractors for construction work.

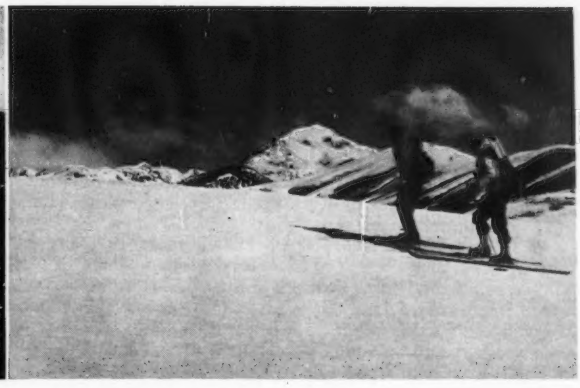
Plans and drainage designs, according to modern standards, are supplied the farmers whose lands are to be drained, whether it be a single farmer or a group job. Ditches are made deep enough to provide for a reasonable period of siltation before the system requires rehabilitation. In all cases, everything possible is done to check the erosion on the silt-contributing watersheds.

Proper design of bank slopes is highly important. As with all structural installations, adequate maintenance is of primary importance.

It is estimated that improved drainage is needed on approximately 37 million acres of wet farm land. This would help to increase the first crop after opening the ditches. Moreover, there are about 20 million acres of rich wet lands not yet cleared that could be put into cultivation. These lands occur throughout the country.

Irrigation, from the time snow and rain fall over the watershed until it reaches the field, involves engineering understanding and practice in water control and utilization. Climatic factors determine the water-flow characteristics of streams. A knowledge of these characteristics is essential for maximum utilization of the available water. Forecasting the annual water supply available for irrigation involves snow

Left: This picture shows the main channel of a drainage ditch being excavated by a dragline scraper • *Right:* This tractor and land leveler are leveling land for irrigation



Left: A sodded waterway established in the spring of 1937. Drainageways or channels protected by thick vegetation carry surplus water off the fields without danger of erosion • *Right:* The task of snow surveying in mountain areas can be accomplished only by surveyors who are expert skiers

surveys reaching back into the farthest part of the watershed, regardless of terrain or weather. And artificial spreading of water over the surface of highly permeable soils for the purpose of replenishing underground water supplies includes the construction of diversions and levees.

Engineering uses basic hydrologic science in the artificial application of water to the soil, either through surface flooding, furrow irrigation, or application by sprinklers. Such facts are needed for the determination of the water requirements of irrigated crops on different types of land. They have to do with evaporation, transpiration, percolation, and runoff. They are affected also by climatic factors and the physical characteristics of the soil. One of the most important factors of irrigation is the preparation of land for the artificial application of water. To be most effective and in order best to conserve water and soil, the water must be applied uniformly and in minimum quantity, rather than in excessive amount. This frequently demands extensive leveling of the land and the construction of canals and essential laterals for distributing the water, measuring devices, checks, headgates, and drops for controlling the flow. And the lining of canals and ditches must be looked after to prevent seepage losses.

Wherever irrigation is practiced, sooner or later portions of the area become waterlogged. Under these conditions alkali accumulates. Drainage systems are necessary to correct such conditions. About eight million acres of irrigated land in the West are in need of drainage.

Widespread application of conservation measures and practices in irrigated areas has created heavy demands for engineering assistance. More than half of the 21 million acres of irrigated land in the United States is included in soil conservation districts. Farmers are beginning to realize that the skill with which they operate their irrigation systems is one of the most important factors under their control affecting agriculture.

Understanding of sedimentation is fundamental in the design of practically all major water management and development projects, whether it has to do with impounding of water for irrigation or for flood control. Experience has shown that the design of many storage reservoirs, irrigation and drainage canals, channels for navigation and flood control, bank stabilization, and other water-control projects frequently has been faulty, because the effects of sediment were not properly evaluated. These mistakes were made in many places because of unavailable data.

Adequate protection of reservoirs, harbors, and valley agricultural lands probably can be effected, but we need to know more about the movement of sediment in channels. We must be able to determine readily how much sediment can be transported through a given channel without deposition or scour through proper knowledge of channel dimensions, the character of the material in the banks and bed of the channel, the nature of the vegetative cover, and the range of flow which the channel must carry. This line of research should be continued and expanded to the point where formulas can be produced for general use by field engineers.

It has been found that so many sciences and techniques enter into soil conservation that it has been necessary to redefine modern soil conservation.

Modern soil conservation consists of treating farm and ranch land according to the different kinds of land, as determined by slope, soil, degree of erosion as the result of past treatment of the land, resistance to erosion, climate, etc., with those adaptable vegetative measures and structures, or combination of the two, in such a way as to meet the highly varying conditions encountered across the country. Stated another way,

Two samples of farming on the contour with modern farm machinery

modern soil conservation consists of doing everything that needs to be done to keep land permanently productive while in use, including contributions from soil conservation science, engineering, soil science, botany, agronomy, geology, chemistry, and so on.

If the land is too wet, the modern conservationist would drain it; if it is too dry, he would bring in the needed water; or regulate the water level so as to subirrigate the crops grown on such land. If it is deficient in plant nutrients, he would fertilize it, and so on. In every single case, engineering has a vital contribution to make.

It is well that these facts be known more generally so that we may have greater consideration given to them in our schools. You can't separate engineering and vegetative action in the treatment of land for conservation of soil and water, and you can't safely separate them from various other techniques required for carrying out permanent conservation.

Further, with this understanding of the necessity for treating the land according to its adaptability and needs through the coordinated use of whatever structures or measures are necessary to take care of the situation, we are finding that the thinking and procedures of engineers, agronomists, and other technicians are being broadened to a remarkable degree. An example of this is a recent development of a sort of reciprocal use of water in the vegetable-growing district of South Carolina. On certain low-lying lands where vegetable growing has attained a very high state of development, those farmers who have been applying a ton or more of expensive fertilizer to the acre have tried to utilize every possible means to prevent any kind of retardation of crop growth. They have drained their land with open ditches, so as to reduce to a minimum any retardation of growth by waterlogging. They also have undertaken to irrigate these same lands from wells. At this stage some growers have found that chemistry and engineering enter the situation.

Where the wells were dug too deep, the water was so salty it injured the vegetables. So the engineer and chemist came in to determine at what level the well water was safe for use. In some places it was found that there was danger of excessive salinity at any depth. So they conceived the idea that by storing drainage water immediately following heavy rains in surface excavations, the same water that was taken off the land for the purpose of making it dry enough for maximum plant growth could be turned back on the same land for the purpose of making it wet enough for maximum plant growth. This practice is in common use on many large vegetable farms today and is being extended rapidly.

The engineers are giving splendid cooperation to our soil conservation work, all over the country. Manufacturers of agricultural equipment are giving thorough regional demonstrations of machines designed to facilitate the work of the soil conservationist. They are proving to farmers and soil conservationists in strategic agricultural areas the effectiveness of new machines built to do soil conservation work and modifications of older machines designed to fit them to terrace land, contour land, etc.

Not only this, but what pleases me greatly is the readiness of the farm implement industry to cooperate in developing needed machines for particular conservation purposes or for particular problem areas. This kind of cooperation is likely to move the program ahead to a very considerable degree.

In conclusion, I am convinced that without the science of engineering, and its proper coordination with other basic agricultural sciences, a beginning in effective soil and water conservation could not have come about.

Electric Milk Pasteurizers

(Continued from page 558)

It is claimed by the manufacturer that, by locating the heating unit near the edge of the milk container, convection currents are set up in the milk, thus heating it slowly and preventing scorching or localized overheating. The approval of Underwriters' Laboratories, Inc., is being requested.

In-the-Bottle Pasteurizer. The pasteurizer developed by H. E. Wright Co., 32 Cambridge St., Charlestown, Mass., is an in-the-bottle household unit, about 24x14x10 in in size and weighs 24 lb empty. Its capacity is 9 square quart milk bottles, or 7 round quart milk bottles, or 7 quart fruit jars. In each case an extra bottle filled with water is used for immersing a thermostat which operates at 143 F and is fastened to the cover.

The outer shell of the pasteurizer is made of rustproof metal and finished with baked enamel. The inner shell is made of either cast aluminum or copper and the lid of stainless steel. It is insulated on all sides and bottom with corrugated asbestos sheets. The 1500-w immersion-type heating element operates on 115 v, a-c, 60 cycles. A second thermostat is located in the bottom of the tank which controls the water bath at 147 to 149 F.

The unit is practically automatic in operation. When pasteurizing it is connected to the pressure water system by means of a hose. The capped bottles of milk are then placed in the tank. A little air space should be left in each bottle to allow for expansion of the milk. The cover is put on with the thermostat placed in the bottle of water. The thermostat cord is connected to the control panel. The switch is put in the "on" position and the timer is set in the "off" position. A magnetic valve opens and the water flows into the tank. The depth is controlled by an overflow pipe which can be removed for draining and cleaning the tank. Different lengths of overflow pipe are provided for various heights of bottles. After the tank is filled with water, the timer is set in the "start" position. This automatically cuts off the water flow and turns on the heater. It requires about 50 min to bring the temperature in the water-filled bottle to 143 F. Then the timer, which is set for a 30-min pasteurization period, starts. It stops if the temperature in the bottle falls below 143 F. When pasteurization is completed, the magnetic valve opens and allows cold tap water to circulate around the bottles. Cooling requires about 20 min and the flow of water is stopped by turning the switch to the "off" position. The milk is then ready for use or storage.

This company plans to build a similar pasteurizer for the milk retailer with the same controls operating on 230 v, a-c, 60 cycles, with a 6-kw immersion heater and having a capacity of 29 square quart milk bottles, or 23 round quart milk bottles, or 23 quart fruit jars.

In addition to the cases listed, research was carried on at the University of Texas. High voltage and low amperage was used. The results were not too successful. High-frequency pasteurization investigations were contemplated but the war prevented the securing of the necessary apparatus. Two agricultural colleges expect to do research in this field in the near future. It is also reported that other manufacturers are engaged in investigating the possibilities of producing small pasteurizers.

REFERENCES

Besley, H. E. A Ten-Gallon Electric Milk Pasteurizer. National Rural Electric Project, Report M-11, 1932.

Krewatch, A. V. Second Progress Report on the Development of a Small Milk Pasteurizer. National Rural Electric Project, Report M-17, 1934.

U. S. Public Health Service. Milk Ordinance and Code, Public Health Bulletin No. 220. U. S. Public Health Service, 1939.

Burkhardt, G. J. and England, C. W. A Small Electric Pasteurizer, AGRICULTURAL ENGINEERING, March, 1941.

England, C. W., Wiedemer, Arthur P., and Burkhardt, G. J. A Small Electric Holder-Type Pasteurizer. Journal of Milk Technology, 4 (4) 187, 1941.

Blandy, D. E., and Nixon, M. W. New Developments in Small Electric Milk Pasteurizers. AGRICULTURAL ENGINEERING, July, 1941.

Andrews, John and Fuchs, A. W. National Inventory of Needs for Sanitary Facilities; II Milk Pasteurization Facilities. Reprint No. 2540. U. S. Public Health Service. February 11, 1944.

Ball, C. O. Report on Cold-Ray Pasteurization of Milk, on Behalf of U. S. Technical Industrial Intelligence Sub-Committee. Target No. C22/238. Food and Agriculture, July 30, 1945.

Trout, G. M. and Farrall, A. W. High-Temperature Short-Time Pasteurization. Michigan Special Bulletin 335, February, 1946.

Luckiesh, Matthew. Applications of Germicidal, Erythemal, and Infrared Energy. D. Van Nostrand Co., Inc., New York, N. Y., 1946.

Land-Use Practices on Runoff and Erosion from Agricultural Watersheds

By L. L. Harrold
MEMBER A.S.A.E.

THE hydrologic effect of land-use practices on agricultural watersheds is dependent on many things. Certain practices may prove to be very beneficial on a particular slope in one season. For different rainfalls in similar seasons the same practices may not be so good. Soil differences as well as degree and length of land slope are also factors which influence the effect of land-use practices in the conservation of soil and water.

If these factors were of only minor value, Utopia would be here. One set of prescriptions could be written for all the land. Those who work in agriculture know that there is no sovereign panacea for soil and water control. Each farm field has its own problem. It is Mr. Farm Planner's job to recognize the field problems. It is Mr. Researcher's job to find out how and why various land-use practices operate in the hydrologic cycle under a variety of climate and soil conditions and slopes. A fundamental understanding of these factor behaviors — their limitations and possibilities — enables the researcher to furnish the farm planner with basic recommendations which can be put together to prescribe a conservation plan for each farm field.

We at the North Appalachian experimental watershed feel that there is much to be learned about soil-water-land use behaviors. Yet, we believe that some of the findings, although from short-time studies, should be presented whenever possible. In that way they may help guide the thinking and planning of other workers in the agricultural field.

Words of caution are appropriate here. These findings are preliminary. They are for watersheds of about 3 acres in area. The soils, topography, and climate are representative of that in the North Appalachian Region — southeastern Ohio, western Pennsylvania, West Virginia, and parts of Kentucky. The basic land-use treatments are (1) poor practices generally prevailing in the area about 1935 and (2) improved conservation practices recommended by the state agricultural experiment station. A 4-year rotation of corn, wheat, meadow, meadow is followed on both treatments. The basic differences in practices are given in Table 1.

The major emphasis of this experiment station is the study of the control of water by agricultural and engineering practices. It was realized that such findings to be of practical use to farm fields and drainage basins must come primarily from experiments on whole natural fields. A number of watersheds of about 3 acres in area were therefore selected. Four pairs of watersheds were chosen for the land-use comparison in the 4-year rotation. Each pair have similar soils and slopes. The length of slope from the ridge down to the runoff gage is about 350 ft. Runoff from the concave area concentrates naturally into channels leading to the gage. Artificial pondage above the measuring flume is negligible. All were treated alike for a period of 2 to 3 years so as to determine basic differences in their water behavior.

Graphic Method of Watershed Comparison. The double mass curve method of plotting is used herein to evaluate the effect of conservation practices. The accumulated monthly runoff for one of the pair of watersheds is plotted on the vertical axis and the other on the horizontal axis. The former is that watershed having the poor or prevailing farm practices continuously throughout the duration of the study. It is the basis of the comparison. The other watershed has prevailing farm practices for an initial calibration period. Afterwards conservation practices are used in farming the latter watershed for the remainder of the study.

Theoretically, the double mass curve plotting for the calibration period should establish a trend line. If the two watersheds are similar in all respects, the runoff on both will be the same. The trend line will have, therefore, a 45-deg slope as shown by the line O-A on Fig 1. If the trend line of the initial period does not have a 45-deg slope, the runoff characteristics on the two watersheds are dissimilar. For example, if the trend line was above the 45-deg line, the accumulated runoff from the watershed represented by the vertical scale would be greater than that on the horizontal scale. Watersheds used in this comparison are adjacent to each other, or nearly so. Rainfall on the pairs of watersheds is therefore considered to be identical.

The departure of the double mass curve from the extension of the initial trend line after conservation farming practices are started on the one watershed shows their value for water conservation. The theoretical curve A-F (Fig. 1) shows what might be expected on shallow soils over a long period of time.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Philadelphia, Pa., June, 1947, as a contribution of the Soil and Water Division. The studies on which this paper is based were made in cooperation with the Ohio Agricultural Experiment Station.

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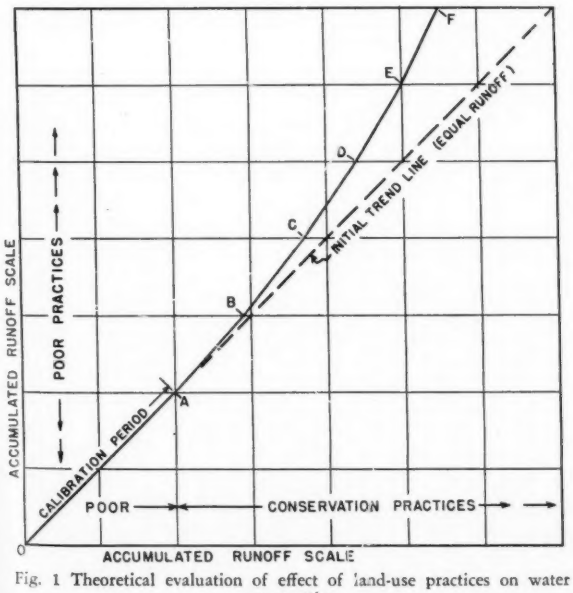


Fig. 1 Theoretical evaluation of effect of land-use practices on water conservation

TABLE 1. PLAN OF WATERSHED TREATMENT

Prevailing Practice Watersheds (poor)		Improved Practice Watersheds (conservation)	
Limed as needed to about pH 5.4		Limed as needed to about pH 6.8	
Crop	*Fertilizer*	*Crop*	*Fertilizer*
Corn (drilled)	75 lb (2-12-6)	Corn (drilled)	200 lb (2-12-6)
Wheat	125 lb (2-12-6)	Wheat	300 lb (2-12-6)
		Meadow 2	100 lb (0-20-0)
Total	200 lb	Total	600 lb
4 tons manure to old meadow turned for corn		4 tons manure top-dressing to wheat; 4 tons manure top-dressing to old meadow in fall previous to plowing for corn	
Preparation, planting, and cultivation off contour — in straight rows		Preparation, planting, and cultivation on contour	

Conservation practices which tend to develop better sod crops including deep-rooted legumes should, in time, increase the organic matter content of the soil. The drainage of the soil should subsequently be improved. Likewise, greater crop production should use more soil water. Thus the volume of empty pores in the soil would be increased and storm infiltration increased. Probably all this is a gradual process—perhaps accelerating up to a certain maximum.

This "dream" or concept is shown graphically on Fig. 1 by the lines A-B, B-C, C-D, D-E, and E-F. During the first year or so after the start of conservation, runoff from the improved watershed may be slightly less than that for the comparison watershed. Thus the slope of the curve (A-B) is greater than the initial trend. For the next period the departure from the trend may be greater yet (B-C), and so on until a maximum possible effect is reached (E-F).

On Fig. 1 the slope of line E-F is greater than that of the initial trend. Runoff for the period E-F from the poor-practice watershed is shown to be twice that for the conservation area for the same period. This means that only half as much water ran off the improved watershed as compared to the area where no conservation practices had been used. The runoff was half. We don't know yet what this final or maximum relationship will be—¾, ½, ¼, ⅛ or ? Neither do we know how long it will take to arrive at the maximum effect. The foregoing is hypothetical. Comparisons for actual farm fields are given in Figs. 2 and 3. The period of record is obviously short.

As a further explanation of the graphic method of watershed comparisons used herein, some of the features of Fig. 2 are described below: Both the total monthly runoff and the annual crop values are shown in the watershed comparisons. Fig. 2 compares these data for poor-practice watershed No. 110 with conservation-practice watershed No. 103. Both were operated the same during 1939-41. Conservation practices on No. 103 started in 1942—the corn season. In Fig. 2-A the accumulated monthly runoff for watershed No. 103 is plotted along the horizontal scale and similar values for No. 110 are plotted in the vertical. Point A shows that by the end of the oat year, 1939, about 7 in of runoff had accumulated from No. 110 and about 5 in from No. 103. Point B shows that by the end of the second year about 19 in of runoff had accumulated from No. 110 and about 14½ in from No. 103 for the 2 years, 1939-40. The amount of runoff for the one wheat year, 1940, is the difference between A and B.

Water Conservation Value of Improved Practices (One Crop). Comparison between watersheds 110 and 103 (Fig. 2) and watersheds 118 and 113 (Fig. 3) are made in this section of the report. The former pair of areas have operated 5 years after improvement was started (Table 1), and the latter pair 4 years. A first glance at the curve of water value for watersheds 110 and 103 indicates that, since the beginning of conservation practices, the trend of runoff for both watersheds is not materially different from that before this time. In other words, conservation practices appear to have had practically no effect on total runoff or water intake into the soil. Runoff on the poor-practice watershed 110 was greater than that on watershed 103 before 103 was improved. This trend has not yet appeared to change 5 years after improvement. The reader will naturally ask the question "When will this change in land have a definite effect in water conservation?" Some of the explanations given here will help to answer this question.

The first year after conservation practices were started on 103, both watersheds were in corn. The rainfall during this year, 1942, was light and the corresponding runoff small (C-D on curve). There was little opportunity for differences to show up. The same holds true for the second year when the watersheds were in wheat (D-E on curve). During the next 2 years, 1944 and 1945, the watersheds' cover was meadow. Most of the runoff occurred in the winter and spring months. The soil moisture was high then and the capacity of profile to transmit moisture into the subsoil controlled runoff. Conservation practices had not yet any apparent effect on the permeability of the subsoil.

If the heavy rains had come in the growing season when differences in vegetal cover affect runoff, the results might have been different. Such was the case for watersheds 118 and 113 (Fig. 3-A). There you will note the striking deviation from the initial trend for the last two years (E-F-G). Here most of the runoff occurred in the growing season. Conservation practices (Table 1) established a better meadow on watershed 113 and its runoff was much less than that for the poor-practice watershed 118. The saving in water amounted to 6 in.

Now let us revert back to Fig. 2-A—comparing runoff from watershed 103 with that of 110. The portion of the curve G-H indicates very little, if any, conservation improvement beginning to show up even in the fifth year. The trend for the preceding 7 years (up to G) showed the runoff from both, that from 110 being mostly greater than that for 103. The total runoff, 1939-45, on No. 110 was about 10 per cent greater than on No. 103. In the fifth year, 1946, runoff from improved corn watershed 103 was 0.6 in less than poor-practice watershed 110. Runoff from poor-practice watershed 110 was 20 per cent greater than that from No. 103 under conservation practices. This year (1946) was one of several intense rainstorms.

Contour cultivation—a conservation practice—is applied to the entire watershed without point rows, without basin listing, and with the usual cultivating tools. Each contour row holds some water temporarily at least. From the experimental data (1946) available here on whole farm fields, contour furrows on cornland area No. 103 retarded flow but did not greatly reduce amount of runoff when compared to straight-row corn on area No. 110. In this case, the drainage of the subsoil on both watersheds is slow. Rain water absorbed by the topsoil layer, 7 in deep, soon filled the available pore space in this layer, Schiff and Dreibelbis[1]. Surface runoff then oc-

[1]Schiff and Dreibelbis. Infiltration, Soil Moisture, and Land-Use Relationships with Reference to Surface Runoff. Trans. Am. Geophysical Union, 1947 (not yet published).

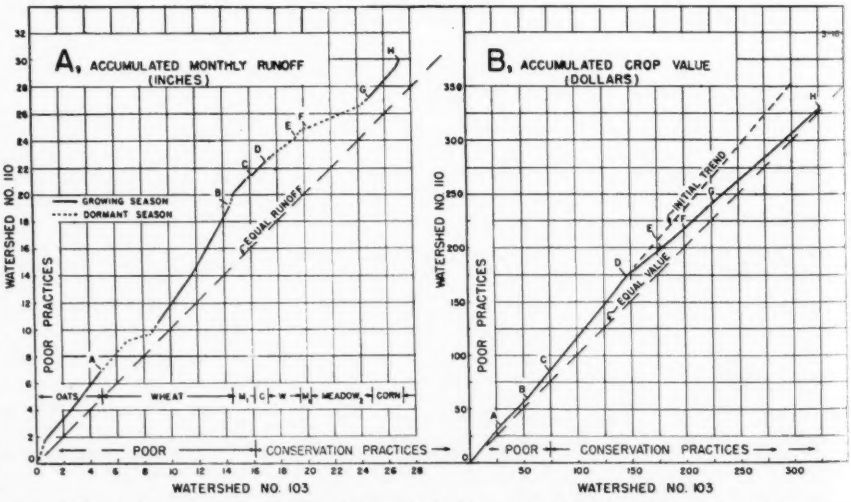


Fig. 2 Comparison of conservation-practice watershed No. 103 with poor-practice watershed No. 110; A, monthly runoff, and B, crop value, 1939-46

curred because the rainfall rates exceed the very slow rate of water percolating through the top of the subsoil. The fact that there has been very little difference in the runoff volumes from this pair of watersheds (110 and 103) indicates that conservation practices have not materially affected the available pore space in the topsoil. Topsoil depth on both watersheds is about the same. As erosion is greater on the poor-practice area more subsoil is mixed in the plow layer each corn year in the rotation. In such areas the capacity of the topsoil to absorb and transmit water is expected to diminish. The available pore space in the topsoil of the conservation watershed should, therefore, in time be considerably greater than that in poor practices. Consequently, more water will also be conserved.

The fact that the difference in runoff volumes from watersheds 110 and 103 are not apparent, further indicates that the improved farming practices have not improved the percolation of water into the subsoil. Thus there was no improvement in the use of the pore space below the topsoil. Deep-rooted legumes in the conservation program may, in time, loosen the subsoil. Mechanical means of loosening are to be tried. Much needs to be done along these experimental lines to get the most out of conservation farming.

In the better-drained soils on watersheds 118 and 113 (Fig. 3-A) the percolation rate into the top of the subsoil is greater. The influence of conservation practices on watershed 113 is apparently not restricted by the subsoil permeability. Portions of the curve, E-F-G, show that conservation practices saved almost 6 in of water. This portion of the curve is a striking departure from the trend prior to the start of conservation practices.

The effectiveness of contouring on cornland to conserve water is greatest for storms less than 1 in in total rainfall. In 1945 most of the June to September storms were small. Although no data for cornland in this year are given in this paper, some comparisons may be appropriate. There were 12 runoff periods on the straight-row cornfield. The contoured cornfield had only one runoff period. More water—1.26 in more—was saved on the contoured field. Soil loss on both fields was less than ½ ton per acre.

In 1946 there were more of the larger storms (Fig. 2-A, line G-H). Consequently, the effectiveness of these contour rows was not as great. In fact, there were just as many runoff periods on the contoured cornfield (No. 103) as on the one in straight rows (No. 110). Runoff for the period June-September on the former was 2.21 in and on the latter 2.83 in. Contouring was effective in saving only 0.62 in of water. The amount of soil saved was a very different story. This amounted to 15 tons per acre. Each acre of the contoured field (conservation practices) lost 4 tons of soil compared to 19 tons from the straight-row field (poor practices). The straight rows were at right angles to the major drainage areas of the watershed. They were not straight up and down the hill. The first year of the improved practice, 1942, there was no apparent conservation of water (line C-D), yet considerable soil was saved. Each acre of poor-practice watershed 110 lost 21 tons of soil in runoff water. Conservation watershed 103 lost only 5 tons per acre.

Water Conservation Value of Mulch Culture on Cornland. A farming procedure not listed in Table 1, but which may have much promise for conservation in some areas, is "mulch culture." Mulch culture in cornfields at this station has been found to protect soil surfaces from sealing under the impact of rain drops. One year's data (1943) on watersheds indicate that this practice may have large possibilities as a "water saver." Fig. 4 shows how much the flood peaks and total runoff on the mulched corn watershed 188 were reduced. The data on this figure shows that the runoff from both watersheds (Nos. 106 and 188) was about the same when they were treated alike, 1941 and 1943. Mulch culture for corn on No. 188 in 1944 was accompanied by considerable water conservation. This practice appears to have an effect on water conservation the first year it is practiced. It does not take several years to show up. We do not yet know, however, what long-time effect mulching will have on soil structure, water movement, and crop yields. These factors can not be neglected. It seems reasonable that this practice will prove best when rains causing soil surface sealing occur, when there is a large volume of unfilled pores in the topsoil, and with a well-drained subsoil.

Water Conservation Value of Strip Cropping vs. Contouring (Watersheds 113 and 124). Both watersheds began to be treated according to improved recommendations in 1943. Records for one complete 4-year rotation since that time show practically no difference in the total runoff. The portion of the curve C-G (Fig. 5) indicates that 6.7 in of water ran off the contoured watershed 113 in the 4 years. Similarly, 6.3 in of water was lost from contour strip-cropped watershed 124. During the first period of the rotation, watershed 113 was entirely in corn. Its runoff for the May to September period was 3.7 in. During the same season, runoff from the corn-meadow strips on watershed 124 was 0.6 in. This comparison is shown by the line C-D in Fig. 5.

Runoff from these watersheds when wheat and wheat-meadow strips covered the land (second period of the rotation line D-E), was small. There was little difference between these values. Similarly, there was no difference in the runoff values in the fourth period of the rotation (F-G). Then watershed 113 was entirely in meadow and 124 was in wheat-meadow strips. During the third period of the rotation (E-F), watershed 113 was in meadow and 124 had corn-meadow strips. The runoff then was 1.2 in from No. 113 and 3.5 in from No. 124.

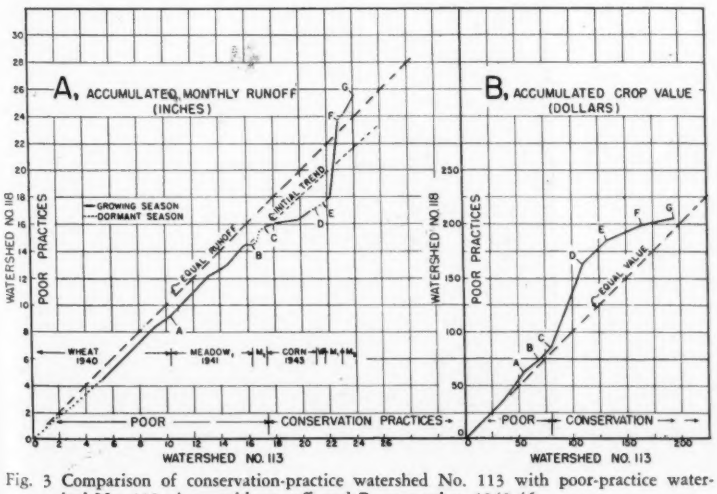


Fig. 3 Comparison of conservation-practice watershed No. 113 with poor-practice watershed No. 118; A, monthly runoff, and B, crop value, 1940-46

The difference in runoff for the first period, C-D, was 3.1 in and for the third period, E-F, was 2.3 in in the opposite direction. One may conclude that although strip cropping did not conserve much water over an entire rotation, there was a tendency for the runoff to be distributed more evenly throughout the 4 years. From farm fields in one crop the runoff is usually concentrated in the corn season. Differences in rainfall distribution throughout the next 4 years may change this conclusion somewhat.

Soil loss in runoff water for 1946 from an 8-acre corn watershed (poor practices) totaled 12 tons per acre. In contrast, an 8-acre, strip-cropped field (corn and meadow strips) lost 2 tons per acre. Corn will not appear on the poor-practice watershed until 1950, whereas there will be corn strips every 2 years on the strip-cropped area. If the year 1946 could be considered average, the 4-year soil loss from the poor-practice watershed would total about 14 tons per acre, or 3½ tons per year. Simi-

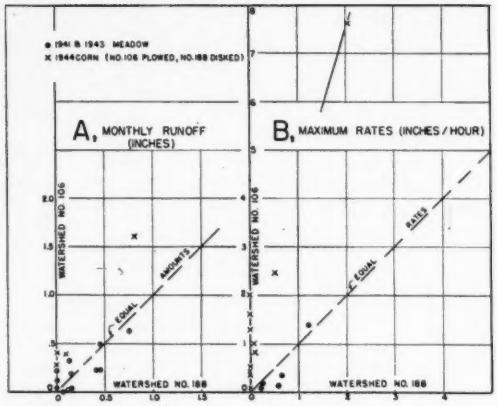


Fig. 4 Comparison of A, monthly runoff, and B, maximum rates of runoff, for May-September period. Mulch culture on watershed No. 188 began in 1944

larly, the 4-year soil loss from the strip-cropped watershed would total about 5 tons per acre, or 1¼ tons per year. This is the first year that records of soil loss have been obtained from strip-cropped natural watersheds of significant size. Additional years of record will prove interesting and valuable.

Dollar Value of Conservation Practices. From a hydrologic point of view, some of the conservation practices may not reveal their full benefit the first rotation or even the second. It may be that the water value of their effectiveness should accelerate as time goes on. From standpoint of dollar value of crops, the benefit shows up the second year (Figs. 2-B and 3-B). From the second year conservation practices were started, the comparison of dollar value of crop yields (D, E, F, G, H) have deviated from the trend in the preceding years (A, B, C, D, Fig. 2-B).

SUMMARY

From the relatively short records available at this experiment station, some tentative conclusions can be drawn:

1 Improved agronomic practices such as increased fertilizer and lime rates and use of alfalfa in the rotation have not had a material effect on water conservation for the period studied on areas having the poorer drained subsoils. Deep-rooted legumes in time may be expected to conserve considerable quantities of water. Ripping the subsoil by mechanical means may also have some possibilities for improved water intake into the soil.

2 Conservation practices such as indicated in Table 1 are planned to produce good sod crops. These furnish excellent protection to the ground surface. Thus raindrops do not puddle and seal the soil surface. On areas having well-drained subsoils, large quantities of water can be taken up and stored provided surface sealing does not occur. In this way, the good sods in the conservation practices are effective in water conservation as soon as the sod can be established. The first year a good sod was established in the improved plan, which was the third year of the rotation on watershed 113, less runoff water was lost.

3 Contour cultivation of corn has not yet been effective in conserving water for storms over 1 in in amount. For smaller storms some water is saved in the contour furrows. It is the larger storms which cause the greatest damage to agricultural areas. For these a significant amount of soil is kept on the land if the area is contoured and good sod waterways provided. In 1946, a year of heavy storms, each acre of the contoured field with sod waterways lost 4 tons of soil as compared to 19 tons of soil loss from the straight-row cornfield. Sod waterways were also provided in the straight-row field. There was only 0.6 in of water saved during this same period.

On contoured cornfields where there is little opportunity to have sod waterways, the soil loss is almost the same as in the straight-row field (1943).

4 Mulch culture for corn provides an effective means of protecting the soil surface from sealing under the impact of raindrops. More water can be conserved. This is especially true if the subsoil drains readily. The effect of the mulch in conserving water is immediate — the first year of the improved practices. A long-time study of mulch culture in the rotation is needed to determine the trends in soil structure, organic matter, and fertility.

5 Strip cropping is not so much a "water saver" as it is a "soil-loss retarder." The runoff from this 4-year rotation single-crop watershed 113 occurred mostly when the area was in corn, 1943. Runoff from this strip-cropped watershed 124 also in 4-year rotation, was more evenly distributed over the 4 years.

The data collected and analyzed during the next rotation or two are expected to throw much light on the possibilities of various conservation practices in controlling water and soil loss.

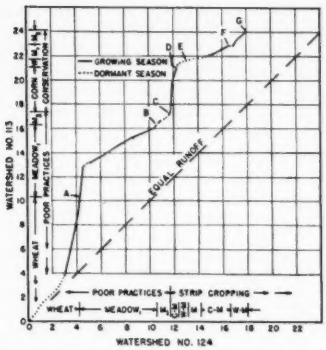


Fig. 5 Comparison of conservation-practice watershed No. 113 and strip-cropped watershed No. 124; accumulated monthly runoff in inches, 1940-46

The large plow in this picture (in operation in Imperial County, Calif.) is working 4 ft deep and is plowing ½ acre per hour. Two Caterpillar diesel D8 tractors furnish the power. The purpose of the deep plowing is to bring up sandy soil for mixing with the top soil to eliminate plow sole

Light-Weight Portable Pipe for Irrigation

By F. W. Peikert
MEMBER A.S.A.E.

DURING the past few years there has been a great deal of interest in supplemental irrigation in nearly all humid areas. The idea of irrigation in these areas is not new as there has been a limited use of the permanent overhead pipe on small intensively cultivated areas for many years. However, now for the first time irrigation is being practiced on a large scale in regions of rather high annual rainfall on such crops as vegetables, small fruits, potatoes, sugar beets, melons, and pastures. This has been made possible largely through the use of light-weight, quick-coupling pipe either with revolving sprinklers or perforations. On a typical installation with 40 to 60 acres under irrigation the entire system, including the cost of the main and distribution pipe, sprinklers, and pumping plant, will cost about $80 to $100 per acre.

Sprinkling irrigation seems to be best suited for most of the areas in the Midwest and East because of certain advantages over other methods. It is adaptable to most any soil or topography; water can be applied rather uniformly in any desired amount and without waste.

The quick-coupling pipe is becoming universally used for practically all supplemental field irrigation. It is also gaining acceptance in some of the drier regions in the West where either flooding or furrow irrigation has been considered the standard practice.

The layout of a portable pipe sprinkler system is an individual problem on every farm influenced by such factors as distance, location, and amount of the available water supply, shape of the field, soil type, crops and the general farming program. The system is usually supplied through dealers who must determine the requirement on any given farm. Perhaps the greatest need at present in our whole supplemental irrigation program is for more specific engineering information for use by the dealers and advisory agents on which to base the layout of their irrigation systems. We also need to know more about where supplemental irrigation will fit into the whole picture of agricultural production. Some of this information is now available and need only be compiled into a usable form for those who make most of the layouts, but there are still many questions that are left wholly or partially unanswered.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Philadelphia, Pa., June, 1947, as a contribution of the Soil and Water Division.

F. W. PEIKERT is professor of agricultural engineering at Michigan State College.

The following are some of the points which continue to come up and on which we need further information in order to carry on a sound program of supplemental irrigation:

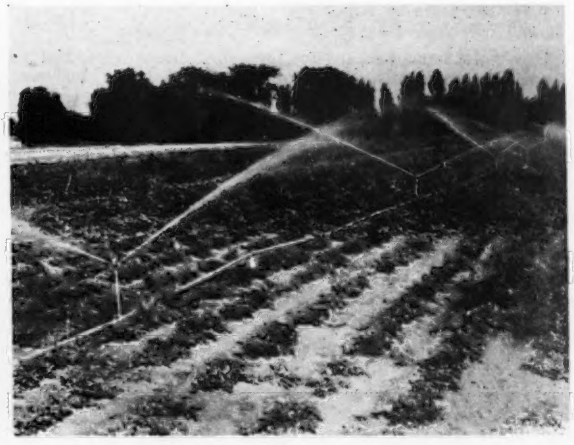
1 *How far can we go in recommending irrigation in the humid regions?* There is sufficient data available from farmers to show quite conclusively that it pays to irrigate the shallow-rooted crops such as vegetables, potatoes, strawberries, and melons even in areas of high rainfall. We do not have sufficient data to show whether it pays in the Midwest to irrigate orchards, vineyards, hay and forage crops, or field crops such as corn, beans, and sugar beets. Farmers are asking whether they can afford to irrigate these last-named crops. On Midwest farms where water is available, can we consider irrigation as one of the desirable annual practices just as cultivation or spraying that will pay its way every year, or must it be more in the order of crop insurance—something that a farmer will have available and use only in seasons of excessive drought? Some of the farmers of Michigan are irrigating orchards, but we do not yet have the necessary data to say whether irrigation can be profitably used every year, only in seasons of drought, or at all.

2 *What is the proper time to apply water with reference to the development on any particular crop and how much should be applied?* When sprinkler irrigation is used only to supplement rainfall, the cost per unit of irrigation water is usually quite high. From a study made in Michigan the overall cost including depreciation on the equipment, power, and labor averaged about $3.75 per acre-inch. Some farmers only have a limited supply of water available. Therefore, we need to know more about when to irrigate in order to get the greatest response from the crop.

3 *What is the effect of sprinkling water directly on the plants?* Farmers frequently ask whether it is safe to use a sprinkler system during the hot part of the day. We know that it is being done on certain crops without any apparent damage, but can it be recommended on cucumbers or certain other crops? Some growers are also concerned about getting the foliage of trees wet when using sprinklers in orchards because of the possibilities of spreading certain diseases such as apple scab or brown rot in peaches. There is also the question of whether sprinkler irrigation will wash off the spray materials and thereby make additional spraying necessary.

4 *What is the maximum desirable precipitation rate?* At present, irrigation water is applied at rates varying from ¼ to 1 inch per hour. Precipitation rates must be particularly

Quick-coupling perforated irrigation pipe



Quick-coupling pipe fitted with revolving sprinklers

watched on heavier soils as excessive rates will cause soil packing. On sloping fields there is also the danger of erosion to consider. When water is applied at a slower rate, more pipe and sprinklers are required with a higher resulting cost. Therefore, a proper balance must be reached between a safe rate of application and the initial cost of the system.

5 *What is the proper size of pipe to recommend for a specific installation?* We find that the fixed charges on the equipment amount to approximately 50 per cent of the cost of irrigation. In order to keep the initial cost down and thereby reduce these fixed charges, there is frequently a tendency to use small pipe with a resulting greater cost of power to overcome friction. Since irrigation equipment is used a relatively few days per year, higher friction losses are permissible than in water-works installations, and consequently the same standards for design cannot be used. However, too often in planning an irrigation system proper consideration has not been given to the most economical layout from the standpoint of intial cost of the pipe and the power to overcome friction. We need to establish a set of standards for pipe sizes applicable to portable irrigation systems.

6 *Where is each of the several types of sprinkler systems best suited?* There are three types of equipment used at present for distributing the water from portable pipe. They are (1) conventional revolving sprinklers in sizes that discharge from 5 to 35 gpm at usual operating pressures of 20 to 45 psi, (2) large single sprinklers with capacities of 300 to 500 gpm at 80 to 100 psi pressure, and (3) perforated pipe that operates at 20 psi or less. Each has its merits and more information is needed about the operating characteristics of the various types so that a person figuring an installation knows under what conditions each might best be recommended.

Let us consider the case of one particular model of revolving sprinkler made by a leading manufacturer. In the operation of this type sprinkler a certain amount of overlapping of the wetted area is required to get proper coverage. However, the effect of wind is a very critical factor in the distribution pattern. The manufacturer made up a performance sheet showing the maximum recommended spacing under each condition of pressure and capacity for both square and triangle spacings. Then the entire set of tables had to be qualified for a given maximum wind velocity. This illustration should emphasize that in order to make the most satisfactory sprinkler layout it is necessary to know as much as possible about the performance characteristics of a given sprinkler.

7 *How can the labor requirement for portable pipe irrigation be reduced?* We find that in Michigan it requires about two man-hours of labor per acre-inch of water applied. On this basis, the labor cost is the second largest expense of irrigation and amounts to about one-third of the total cost. The work of moving pipe is quite hard, so, in addition to the cost, there is at present a problem of getting suitable help. There are several ways by which this labor requirement can be reduced. The following are receiving consideration:

(a) Mechanical means for moving the pipe instead of by hand as is now the common practice.

(b) Use of the large single sprinkler in place of a number of smaller sprinklers having a lesser diameter of coverage per setting. With the large sprinkler, the lateral serving as a supply line can be moved two to three times as far for the next setting as with smaller sprinklers. Thereby the pipe need not be uncoupled and reassembled as often to cover a field.

(c) Use of aluminum pipe which only weighs about one-third as much per foot as galvanized iron pipe. One man can carry two 20-ft lengths of the smaller diameters of aluminum pipe instead of one and thereby reduce the amount of walking required to move a line.

(d) Improved layout of the pipe with reference to the crop rows so as to make walking easier when moving pipe.

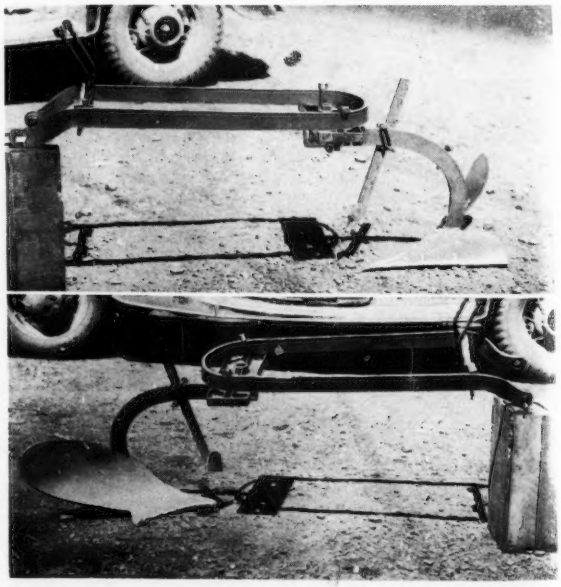
It is now a common practice to lay the laterals parallel to the rows. This arrangement necessitates stepping over each row when carrying pipe to a parallel position. Perhaps on certain crops the laterals might best be laid at right angles to the rows so that a person can then walk down the middle when carrying the pipe.

(e) Improved design of couplers so that they can be latched and unlatched without the operator going to the coupler. Up to now, self-locking couplers have been worked out quite well, but more development work needs to be done to get them to unlatch properly under all conditions.

8 *Are the present laws pertaining to water rights adequate to cover the use of water in the states just getting into a supplemental irrigation program?* In much of the eastern part of the country the common-law doctrine of riparian rights is in effect which provides that each owner along a stream is entitled to have the water flow in its natural channel undiminished in quantity and unimpaired in quality.

In much of the humid region there are numerous small streams which would serve as the most economical source of irrigation water for the nearby landowners. However, if a number of farmers wish to pump from the same stream and perhaps others lower down are also interested in the flow of the water, disagreement is quite apt to develop. In the arid region, satisfactory laws have long been established governing the use of water for irrigation. In other states we should likewise begin to consider suitable laws to cover the right to use water for irrigation purposes.

The present indications are that supplemental irrigation will become a common practice in many parts of the humid region. It is up to us to take the leadership in placing it on a sound basis. The use of the quick-coupling pipe is the most satisfactory method we have at the present. Since irrigation is relatively new in many regions, there is still much that needs to be done to improve present methods and equipment. Several state agricultural experiment stations, the U. S. Department of Agriculture, and manufacturers of pipe and sprinklers are all working on certain phases of this problem. As rapidly as possible, we should attempt to fill in the gaps in the needed information about supplemental irrigation and make such data available to those who are planning the systems on the individual farms. Most of these men are not engineers, but they need the assistance of engineers to provide them with the necessary design information.



These two views show a garden tractor plow designed and built by M. S. Baker, which he says "embodies a counteractive stress cam on the 'snout' of the beam, to resist share thrust from roots, stones, etc. Also, the plow can be easily removed and disk-harrow gangs substituted on the slotted cross plates. Complete adjustments for depth, leveling, and landside pressure are provided"

RESEARCH NOTES

A.S.A.E. members and friends are invited to supply, for publication under this heading, brief news notes and reports on research activities of special agricultural engineering interest, whether of federal or state agencies or of manufacturing and service organizations. This may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Mich.

Flame Cultivation Research in New York

By F. B. WRIGHT

THREE seasons of experimentation with "flaming" as a method of weed control have indicated that this method has considerable merit for certain purposes.

It has been determined that weeds can be controlled by flaming in the following New York state row crops: corn, onions grown from sets, onions grown from seeds after the plant has developed stems, potatoes, deciduous nursery stock, grapes, and orchards.

Flaming has been unsuccessful, or is still questionable, on the following crops: spinach, carrots, beets, tomatoes, green beans, cabbage, peas, peppers, asparagus, small onions grown from seeds, and evergreen nursery stock.

In addition to weed control in crops, experiments have indicated that weed shrubs and trees can be killed by flaming. Also, flaming shows promise as a means of preharvest killing of potato vines together with the intermingled weeds.

Tests indicate that the fuel costs for flame cultivation in row crops will run between 45 and 75 cents per acre per treatment, depending upon the price of fuel, weed population, moisture conditions, and other factors. Crops may require from one to five treatments per season, depending upon type of crop, weed population, type of weed, and amount of rainfall.

Flaming equipment for hand or tractor operation is available at prices ranging from $18 for small hand guns to $1,000 or more for the larger tractor-mounted models.

Flame cultivation is a matter of differential burning. Just enough heat should be applied to kill the weeds, but not enough to kill the crop plants. Some crop plants, such as corn, have more resistance to flame than do the common weeds; therefore, corn is flamed successfully. Other crops, such as spinach and carrots have very little resistance to flame, so that if enough heat is applied to kill even the tenderest weed, the crop will also be killed.

The average person when first trying flame cultivation applies too much heat with results in crop damage. The ideal time to flame cultivate is when the weeds are small and either before the crop emerges or after the crop has attained considerable size. It is not necessary to apply the flame until the weeds are cooked. A very brief blast of the flame on small tender weeds may show no immediate results, but the flame ruptures the cells of the weeds, causes loss of moisture, fermentation, and finally death of the plant. The younger and more tender the weed, the less heat required to accomplish this. The usual rate of travel with flame guns is from 2½ to 3 miles per hour. If the equipment and the time are available, these experiments will be continued during the next growing season.

USDA Research Notes

By JANE TUTTRUP

Weed Control. More effective means of controlling weeds, which increase costs of U. S. crop production an estimated 3 billion dollars annually, will be studied in one of the projects recently approved under the Research and Marketing Act of 1946.

The study is designed to develop practical methods, materials, and equipment for weed control. Basic research on herbicides such as 2,4-D and their effects on plants will be conducted at Beltsville by scientists of the Bureau of Plant Industry, Soils, and Agricultural Engineering. The recent discovery of these new and more effective herbicides has sharply altered the picture of weed control.

Included in the new project will be research on major weed problems of the country organized on a regional basis in cooperation with the state agricultural experiment stations. It will now be possible to initiate studies on weeds of major importance in areas where this has not been done extensively.

The agricultural engineering phases of this project include work on the development of mechanical cultivating, spraying, flaming, and electrical equipment and improved devices for the application of herbicides. It will be centered at Ames, Iowa, and Stoneville, Miss. Agronomic, ecological, and mechanical investigations will first be undertaken on the major weeds of each region and the results will be made available to all cooperators.

* * * *

Farm Labor Housing. A survey of existing housing for migratory labor in the High Plains Area has been made cooperatively by the Farm Labor Unit of the USDA Extension Service, the Colorado Agricultural Experiment Station, and the USDA Division of Farm Buildings and Rural Housing. Morgan County, Colo., was selected for the survey. Farmers of the area, most of whom are sugar beet contractors, realize that assurance of an adequate labor supply at beet thinning and harvest time depends in part on furnishing satisfactory housing for the transient families. Findings of the survey will assist the Division of Farm Buildings and Rural Housing in preparing such house plans.

P. F. Gifford, farm job analyst at Ft. Collins, who made the survey, found that foundations are a distinct weakness in labor houses. Although the light structures can be supported without solid foundations and are occupied mostly in warm weather, foundations are needed for keeping out rodents, skunks, and snakes. For a farmer who does his own excavating and concrete work during a slack season, a basement is probably the cheapest part of a house. Basements were in use in those houses which had them. Most of the High Plains Area is dry enough so that the basement can be used for sleeping quarters.

More and more, Mr. Gifford reports, suitable location of the labor house is being considered. On several farms rather good labor houses are being moved to better locations. The errors in locating houses in the past were many. They were put too close to other farm structures, too far from the road or the water supply, too far from shade and windbreak, too near the corral. In general, the houses are too small. Three rooms, it seems evident, should be the minimum. Attic space and an insulated ceiling are desirable where the house is not shaded.

Much use is made of composition siding as exterior finish, and this is quite satisfactory. Mr. Gifford believes that shiplap of matched lumber is one solution to the problem of interior finish, which is subjected to a great deal of abuse. Metal roofs should probably be considered, as the brilliant sunshine of the area is hard on wood shingles and composition roofs. Porches with concrete floors are recommended, partly for fuel storage.

How Much to Invest in a Barn

TO THE EDITOR:

WHY not build a barn that will return more than a dollar for each dollar invested?

Each time I read an article, such as the good one, entitled "Why Not Build Dairy Barns the Cow Can Pay For?" by B. G. Perkins in AGRICULTURAL ENGINEERING for October, on this subject, I resolve to put in writing the economic principle of diminishing returns as applied to building construction. If buildings are an investment, let us consider them as such instead of as a luxury for the cow and a necessary evil for the farmer.

If we are not careful in our calculations, we may do the cow a great injustice if we build only a barn that "she can pay for". She may be able to pay for a tent or a halter to be tied under a tree, but who would say that is a good investment?

Mr. Perkins has a good approach to an important subject. However, I don't think the cow should be charged for the full amount of $300. Perhaps she can justify $150, and that amount can be written off as one of the costs of producing milk.

However, the next $150 invested may pay for itself several times in labor and feed saved and in increased production. Automatic watering cups will pay for themselves several times during the life of a barn. Don't charge the cow for them.

Twenty-five dollars per cow for insulation in the walls may save that value in feed before the barn has reached half its expected life. At the same time it may keep the cows in more uniform production, and make the operators more comfortable. We shouldn't charge the cow for this insulation.

To keep ourselves from getting confused on how much to pay for a barn, let us review the law of diminishing returns and consider our buildings to be investments.

Let us select a simple example to demonstrate this law. Assume seed oats cost twice as much per bushel as feeding oats harvested from the field. Therefore, for every bushel planted more than two bushels must be harvested. Ordinarily there will be this harvest for the first two and one-half or three bushels planted per acre, but above this amount the extra seed is not warranted. The point of a diminishing return is reached.

Our seed oats are building materials and labor to erect them. Our harvested oats are net dollars for the dairy enterprise. Let us seed all dollars worth of building materials and labor (along with other investments involved in the dairy enterprise) that will return more than a dollar during the expected life of a structure.

Dollars invested in longer life, insulation to save feed, doors and passages to save labor, steel stalls to save udders, drinking cups to increase milk flow—all will usually return with a big profit. As I understand the problem, it is not so much what a cow can pay for, but rather, can the expenditure be expected to return a profit on the investment?

CLARK PRUDHON

Engineer, James Mfg. Co.

NEWS SECTION

Southeast Section to Meet in Washington

THE officers of the Southeast Section of the American Society of Agricultural Engineers announce that the next meeting of the Section will be held February 12 to 14, 1948, at the Hamilton Hotel in Washington, D. C., in conjunction with the annual convention of the Association of Southern Agricultural Workers. An interesting program is beiing arranged, and will be announced in some detail in these columns i nthe next issue.

Section officers extend a cordial invitation to all friends and members of A.S.A.E. to attend the meeting in Washington. A block of rooms has ben set aside by the Hamilton Hotel for those attending the Southeast Section meeting, and this meeting should be mentioned in requesting guest room reservations.

President Rietz Given Honorary Degree

AN Honorary American Farmer Degree, the highest award given by the Future Farmers of America organization, was recently conferred on George A. Rietz, president of the American Society of Agricultural Engineers, and manager of the farm industry division of the General Electric Company.

Presentation of the degree with gold key and certificate was made by the president of F.F.A. at their national convention at Kansas City in October. Among others who received the degree this year were Hon. Clinton P. Anderson, Secretary of Agriculture, and Lord Inverchapel, ambassador of Great Britain to this country.

Bainer Now A-E Head at California

THROUGH an oversight, previous announcement in these columns has not been made of the appointment of Roy Bainer to succeed H. B. Walker as head of the division of agricultural engineering of the University of California at Davis, which became effective last July 1st.

Professor Bainer is an agricultural engineering graduate of Kansas State College, where he also received his master's degree in agricultural engineering. He joined the agricultural engineering staff of the University of California in 1929, with which he has been continuously connected.

At California Mr. Bainer's contributions to agricultural engineering research and development have been outstanding, including segmentation and decortication of sugar beet seed, pelleting and precision planting of row chops, a sugar beet harvester, a bean thresher, internal-combustion nut cracker, harvesting and drying of rice, flax harvesting equipment, and rural fire fighting equipment. During World War II, at the request of the British Government, he spent some time in England counseling on problems in connection with the mechanization of agricultural production there.

Abstract of Patents Published

A BOOKLET, entitled "Abstracts of Patents in the Field of Agricultural Engineering", listing patents vested in the Attorney General of the United States, has been published by the American Society of Agricultural Engineers.

The United States patents covered were owned by alien interests or interests in alien-occupied countries at the entry of the United States into World War II, and rights therein were confiscated by the Alien Property Custodian. At the latter's request a committee of the Society reviewed the field, indicated the classifications of primary interest to agricultural engineers, screened out many of the patents in these classifications and indicated approximately 325 patents as likely to be of some interest and possible application in the United States. Some of these may be primarily of negative interest, showing developments no longer new and patentable. Others may cover features subject to possible useful embodiment in manufacture in the United States.

The policy of the Office of Alien Property, U. S. Department of Justice, favors the use of such patents where possible, under licensing agreements, in the interest of the economy of this country. It was in furtherance of this policy that the Society screened the patents available, abstracted those of apparent greatest interest, and published the list of abstracts.

The publication is a 24-page, 6x9-inch booklet. Due to the limited demand anticipated, it has been necessary to price the booklets at $1.00 per copy postpaid. Copies may be obtained from the headquarters office of the Society at St. Joseph, Michigan.

A.S.A.E. Meetings Calendar

December 15 to 17 — WINTER MEETING, Stevens Hotel, Chicago.

February 6 and 7 — PACIFIC COAST SECTION, Yuma, Ariz.

February 12 to 14 — SOUTHEAST SECTION, Hamilton Hotel, Washington, D. C.

April 29 to May 1 — MISSOURI SECTION, Hotel Muehlebach, Kansas City, Mo.

June 21 to 24 — ANNUAL MEETING, Multnomah Hotel, Portland, Oregon.

October 21 and 22 — PACIFIC NORTHWEST SECTION, Columbia Gorge Hotel, Kansas City, Mo.

Bonner New Chairman Pa. Section

AT A meeting of the Pennsylvania Section of the American Society of Agricultural Engineers held in the agricultural engineering building on the Pennsylvania State College campus at State College, October 23 and 24, Edwin K. Bonner, Jr., design engineer, S. L. Allen Co., was elected chairman of the Section for the ensuing year. D. C. Sprague, professor of agricultural engineering, Pennsylvania State College, was elected vice-chairman, and Ralph E. Patterson was re-elected secretary-treasurer. The new nominating committee consists of A. W. Clyde (chairman), C. G. Burress, and Stanley Bidlack.

Members and friends of the Section came from all parts of the state to attend the meeting, and an attendance of 77 was recorded at the annual dinner held on the evening of October 23. Charles A. McDade retiring Section chairman presided as toastmaster. The high point of the dinner program was an address by Harry Restofski, sales promotion manager of the West Penn Power Company.

Peterson Elected Chicago Section Chairman

WALTER R. PETERSON, agricultural engineer in charge of the International Harvester Company's experimental farm at Hinsdale, Ill., was elected chairman of the Chicago Section of the American Society of Agricultural Engineers at the Section meeting on October 20. In addition, two vice-chairmen were elected, Don H. Anderson, sales manager, Aermotor Co., and Cameron E. Hervey, associate editor of "Farm Journal". Howard C. Rutt, one of the rural electrification specialists of the Public Service Co. of Northern Illinois, was elected secretary-treasurer.

The meeting included, in addition to the usual Section dinner, a short business meeting, mainly for the election of officers, and a specially conducted tour of the International Harvester Company's farm machinery exhibit at Soldiers' Field.

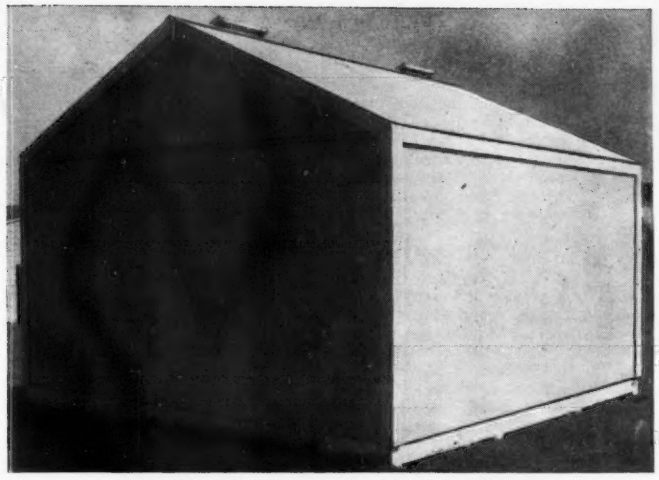
Agricultural Engineering Training

BEFORE the engineering education section of the Association of Land-Grant Colleges and Universities, meeting in Washington November 10, A. W. Turner discussed the place of agricultural engineering in the land-grant schools. He pointed out that just as transportation, mining, petroleum, and other industries have their engineers, so agriculture, the world's original, basic, and largest industry, deserves a goodly number of specially trained engineers.

Emphasizing the importance of food in war and peace and the present world starvation, Mr. Turner warned of the limitations on increasing the amount of land in cultivation and asserted that the alternative is to boost production from the present cultivated area through advancements in science and engineering. He recalled that the change from animal power to machine power alone released many thousands of acres which became available for increased production of foods. Our efficiency has been increased in many other ways through the results of research, both public and private, in the field of agricultural engineering.

Mr. Turner examined the background which an agricultural engineer should have, pointing out that he must know agricultural fundamentals in addition to having the technical knowledge of the engineer who goes into any other industrial field. For example, a knowledge of soil physics is needed to approach such problems as these: What is the nature and frequency of cultivation needed to control weeds and to stimulate maximum production in any given soil and for each particular crop? What are the possibilities of using chemicals, heat, and electric energy in weed treatment in the various field operations?

(Continued on page 572)



Plywood Grain Bin

—Prefabricated
—Demountable
—Multi-Purpose

This Completed Bin Provides Excellent Storage

Construction Notes

FOUNDATION—Concrete blocks laid loose in shallow trenches at two ends and at quarter-points of floor span. Two by six inch girders laid on blocks.

FLOOR—Four panels 4 by 16 feet, joists 2"x8"-x16' spaced 16" o.c. Flooring ¼" Exterior Douglas fir plywood. [Should be increased to ⅜" to minimize deflection under load.]

WALLS—Sixteen panels 4 by 8 feet, one with door built in. Studs 2"x4"x8' spaced 12" o.c. Siding ¼" Exterior Douglas fir plywood nailed to outer stud face.

CROSS TIES—Two by six inch ties spaced 4' o.c.

GABLE ENDS—Studs 2"x4" spaced 2' o.c. Sheathing ¼" Exterior Douglas fir plywood. Joint flashed.

ROOF—Eight panels, one with built-in filling door. Rafters 2"x4" spaced 2' o.c. Roofing ¼" Exterior Douglas fir plywood, painted.

ITEMIZED COST—

Materials:	Lumber	112.51	
	Plywood	100.80	
	Other materials	38.85	252.16
Labor:	Fabrication	165.00	
	Painting [prime coat]	12.00	
	Erection [not included]		177.00
	Total		**$429.16**

A PLYWOOD GRAIN BIN erected at the University of Illinois (Plan No. 434) in 1942 incorporated several unique features. It was prefabricated, except for trim, in a local lumber yard using simple jig tables and standard woodworking equipment. Machine work totaling 11¼ hours at $2.40, and 92 hours of bench work, including jig set-up, at $1.50 are included in the cost.

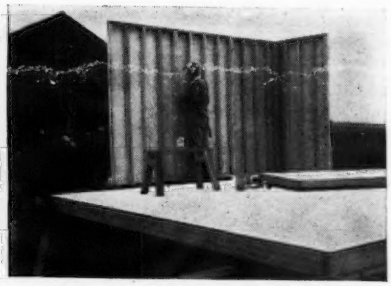
Only 4 man-days of labor were required for erection at the site. An appreciable portion of this time was required for fitting trim, indicating that simplification of trim detailing would effect appreciable economies. Both fabrication and erection crews were inexperienced with plywood and prefabricated construction. The parts fitted together perfectly, with the exception of minor corrections for the last two roof panels, caused by not having the floor level.

All parts of the bin except trim were bolted together, providing demountability for moving. A tenant farmer investing in such a structure would be assured of 100 per cent salvage.

The structure was a conventional gable-roofed design suitable for numerous other farm uses. Wall and corner bracing was eliminated as being unnecessary for plywood construction. Cross-ties were placed above head-height to permit ready access. If desired, individual wall and ceiling panels can be removed and replaced by others with doors or windows.

The unusual advantages expected of plywood construction — tightness, rigidity, sturdiness — have characterized the five years of use of this bin for soybean storage. The cost of the structure, obviously greater per unit storage than that of many round bins, was within a competitive range. Considering its pleasing appearance, care of erection, demountability and multi-purpose use, it constitutes an economical design. Blueprints of the plan may be obtained for 30c per set from the Department of Agricultural Engineering, University of Illinois, Urbana, Illinois.

1. Bin parts were prefabricated in a local lumber yard.



2. Floor panels 4 by 16 feet in size and wall panels 4 by 8 feet were quickly bolted together by the two-man erection crew.

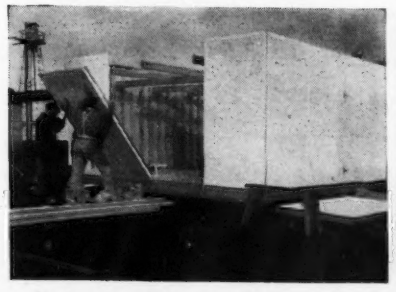
DOUGLAS FIR PLYWOOD

Douglas Fir PLYWOOD

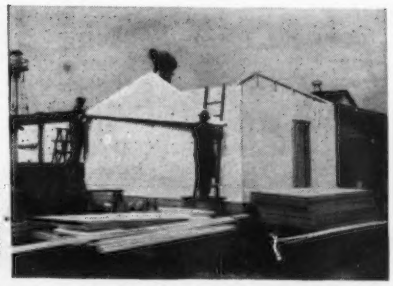
Large, Light, Strong —Real Wood Panels

DOUGLAS FIR PLYWOOD ASSOCIATION

Tacoma 2, Washington



3. Cross-ties with beveled top edges were placed above head-height.

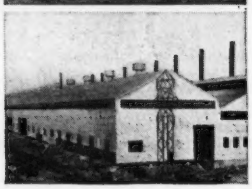


4. Gable end and roof panels were bolted to the plates.

TIME

PROVES

Galvanized (ZINC-COATED) Sheets Stay Stronger Longer



34 YEARS . . . Erected in 1913, and covered with heavy gauge galvanized sheets, this Tennessee concentrating plant of the A/Z Company, pictured at left, is still in excellent condition after more than three decades of service. Painted with Gray Metallic Zinc Paint in 1932.

50 YEARS . . . The galvanized metal roof on this old Missouri farm building has outlasted the building itself, and is still in good condition after half a century of service. Industry and the farm have long depended on galvanizing to protect iron and steel against costly rust. Builders know that as long as iron or steel is zinc covered, it *cannot rust.*

In building for the future, look to the past for proof of a building material's strength . . . durability . . . service. With *galvanized* (zinc-coated) roofing and siding you get the strength of steel . . . the rust protection of Zinc. So for low-cost, long-time service choose the building material that's proved by TIME itself . . . galvanized sheets. Send coupon for information about Zinc and how it helps keep buildings and equipment *stronger longer.*

ZINC INSTITUTE 2 OZ. COATING SEAL OF QUALITY

This "Seal of Quality" is your guide to economy in buying galvanized sheets. Sheets bearing it carry at least 2 oz. Zinc per sq. ft.

American Zinc Institute

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FREE BOOKLETS!

Send me without cost or obligation the illustrated booklets I have checked.

- ☐ Repair Manual on Galvanized Roofing and Siding
- ☐ Facts about Galvanized Sheets
- ☐ Use of Metallic Zinc Paint to Protect Metal Surfaces

Name_____

Address_____

Town_____ State_____

NEWS SECTION

(Continued from page 570)

In Mr. Turner's opinion the administration of agricultural engineering training should be a joint responsibility between the dean of engineering and the dean of agriculture. It will not be sufficient to reshuffle the present engineering and agricultural courses and expect the agricultural engineer to sift out the wheat from the chaff. One of the handicaps in agricultural engineering training today is insufficient text materials and teaching examples of engineering applications to agriculture. Much essential material could be concentrated into fewer and more useful courses.

Oregon Reorganizes A-E Training

OREGON State College recently announced that hereafter it will offer and clearly distinguished between training for a professional degree in agricultural engineering, and training in agriculture with a major in agricultural engineering.

The deans of engineering and agriculture will collaborate on administration of the instruction, with the dean of engineering giving major attontion to the professional curriculum, and the dean of agriculture primarily concerned with service courses and with agricultural engineering as a major subject for degrees in agriculture.

J. B. Rodgers, head of the department, indicated in announcing the program that it is intended to bring the school in line with the national trend in administration of the two distinct types of agricultural engineering instruction.

Open Forum on Tractor Fuels

TECHNICAL Committee I on Tractor Fuels of the American Society for Testing Materials is sponsoring an open forum on tractor fuels to be held in the Michigan Room, Edgewater Beach Hotel, Chicago at 1:30 p.m., January 9, 1948. The program is made up of the following speakers and subjects: H. E. Everett, editor, "Implement & Tractor," on tractor statistics as related to the farmer; E. L. Barger, agricultural engineer, Iowa State College, on the farmers' interest in tractor fuels; Raymon Bowers, assistant chief engineer, mechanical research and development division, International Harvester Co., on tractor requirements as related to fuels; A. B. Anderson, director of petroleum division, Minnesota Department of Taxation, on complexity of tractor fuels and taxation, and C. N. Hinkle, Standard Oil Co., on the effect of state regulations and state specifications on tractor fuels. Persons interested are welcome to attend. Additional information about the program may be secured from R. E. Vogel, secretary, Technical Committee I, in care of Sales Technical Service Dept., Standard Oil Co., 910 S. Michigan Ave., Chicago 80, Ill.

A-E Fellowships Open in Central America

FOUR fellowships in agricultural engineering at the Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica, are currently open according to word received from Norton C. Ives, chief of the agricultural engineering department. Relative to the opportunities presented, Mr. Ives says in part: "In the agricultural engineering field we are particularly interested in getting some graduate students with good agricultural backgrounds, so they would be able to go ahead more or less on their own. Opportunities are wide open for agricultural engineers in all fields down here, especially for persons who know the language and have had some actual experience of conditions and needs. Also, we offer a master's degree for one year's work, providing of course that the requirements are fulfilled."

The Institute was established in 1944 by convention agreement between the American republics. It is supported by quota funds from member countries, and by special grants from organizations interesteed in products of tropical agriculture. The governing board of the Pan American Union serves as its board of directors.

Turrialba is located in the Atlantic zone of Costa Rica, in an area devoted to production of sugar cane, coffee, and cattle. The Institute property covers 2,500 acres at 2000-ft elevation and is largely devoted to experimental plots for plant introduction and other agricultural research.

Adjacent to the Institute is the Cooperative Rubber Experiment Station of the U. S. Department of Agriculture and the Costa Rican Ministry of Agriculture. Nearby agricultural areas at lower and higher elevations provide within a few miles a wide range of agricultural climates from tropical to temperate.

The Institute is primarily a center for research, graduate study, and extension work, and cooperates with similar agencies in all of the American republics. It offers facilities for research for scientists on sabbatic or summer term leave, for advanced graduate students; for persons interested in one or two years of additional study and research to increase their professional competence, and for persons desiring special training in specific techniques in tropical agriculture.

Agricultural engineering in the Institute is concerned particularly with drainage, soil erosion control, and farm machinery.

Applicants for the fellowships should send full training and experience record and health certificate to Norton C. Ives, chief, agricultural engineering department, Inter-American Institute of Agricultural Sciences, P. O. Box 74, Turrialba, Costa Rica.

A new and better MOLDBOARD PLOW built for the new Ford TRACTOR

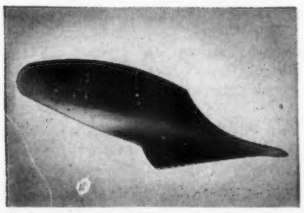
THIS simple, sturdy plow typifies the advanced engineering behind the entire Dearborn line. It is designed specifically for use with the Ford Tractor and is operated by Ford Hydraulic Touch Control. With no wheels, axles, clutch, tongue, springs or levers to bother with or get out of order, it carries only the frame and working parts necessary for plowing. It will turn more uniform furrows, under tougher conditions, with less stopping, adjusting, fuss and bother. Like all other Dearborn Farm Implements, this plow can be attached to the Ford Tractor easily and quickly. Some of its many other advantages are shown below. Your local Ford Tractor dealer will be happy to arrange a field demonstration of this improved plow and the new Ford Tractor.

DEARBORN MOTORS CORPORATION
DETROIT 3, MICHIGAN

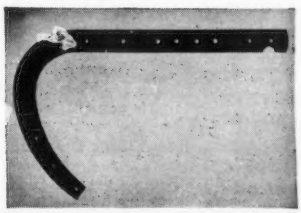
Dearborn FARM EQUIPMENT

COPYRIGHT 1947, DEARBORN MOTORS CORPORATION

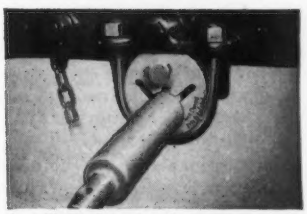
EVERY FARMER WILL APPRECIATE THESE FEATURES...



Carburized steel shares cut clean and reduce draft . . . available in correct shape for your soil.

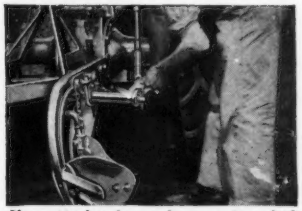


Rugged, forged, one-piece steel beams won't spring or twist . . . provide excellent trash clearance.



A calibrated lead adjustment . . . an eccentric disc—makes adjustment of furrow width simple, easy.

Easily adjusted, high carbon steel coulters and jointers assure clean, vertical furrow walls, good trash coverage.



Plow attaches in a minute or less. It is raised and lowered and depth is maintained, by Ford hydraulic mechanism.

Proof of the Dearborn plow is in the plowing. Users point with pride to the job it does . . . regardless of soil type.

Ford Farming MEANS LESS WORK... MORE INCOME PER ACRE

Concrete converted an old barn into a modern, firesafe, ratproof farrowing house. *Left:* Concrete walls and floors have replaced rotten timbers and sills. *Above:* The completed job with cement asbestos siding and shingles and a clean, concrete-paved yard.

Remodel for a lifetime of low-cost service with

CONCRETE

New labor-saving usefulness can be built into sagging barns, rotting tool sheds and other old farm structures by remodeling and modernizing with concrete. Designing such improvements is a real challenge to agricultural engineers, who must utilize as much of the old building as possible and yet develop sturdy, attractive and economical improvements.

Concrete's firesafety makes it the logical choice for farm building improvements. And its economy—moderate first cost, low upkeep and lifetime service — makes it a wise investment. Many concrete improvements soon pay for themselves in feed and labor saved and in improved animal health.

Agricultural engineers are invited to write for free illustrated literature that will be helpful in designing and building economical, firesafe concrete improvements in dairy barns, milk houses, poultry houses and many other profit-making farm structures. Distributed only in the United States and Canada.

PORTLAND CEMENT ASSOCIATION

Dept. A12-1, 33 W. Grand Ave., Chicago 10, Illinois

A national organization to improve and extend the uses of portland cement and concrete . . . through scientific research and engineering field work

Personals of A.S.A.E. Members

Thomas P. Christen, Jr., formerly design engineer, Ohio Cultivator Division, National Farm Machinery Co-op, is now a sales engineer for the Standard Oil Company.

George A. Crabb, Jr. has been tranferred from the North Appalachian Experimental Watershed Project of the U. S. Soil Conservation Service at Coshocton, Ohio, to become supervisor of the SCS hydraulic research project at Michigan State College, East Lansing.

A. E. W. Johnson, formerly manager of engineering, farm implement division, International Harvester Co., has been appointed director of engineering for the company. Mr. Johnson has been engaged in engineering and development work for the Company for the past 31 years. He joined the Harvester organization at the McCormick Works in 1916 as a draftsman. In 1922 he became designing engineer for harvester-threshers and in 1926 chief engineer. He was appointed assistant manager of implement engineering in 1937 and manager in 1940.

G. A. Patterson, recently resigned his position with Sta-Rite Co. Inc., to accept a position as vice-president of the Peoria Equipment Co., manufacturers and jobbers of equipment and supplies for farm and home.

H. S. Pringle, formerly chief, farm supplies section, emergency action Branch, civilian relations division, Office of Civilian Requirements, is now rural electrification specialist in the Extension Service, U. S. Department of Agriculture.

Imre T. Razso, formerly assistant professor of agricultural engineering, Royal Hungarian Academy of Agriculture in Magyarovar, Hungary—and whom a number of members of A.S.A.E. will recall from his visit to the United States in 1937-38—is now professor and head of the department of agricultural engineering at the University of Agricultural Sciences in Budapest, Hungary.

Albert W. Scarratt, vice-president in charge of engineering patents for International Harvester Co., is retiring after more than 20 years of service with the Company. Mr. Scarratt joined International Harvester in 1927 as chief engineer of motor trucks and coaches after extensive engineering experience in other automotive industries. He was promoted to chief of automotive engineering in 1935 and was appointed assistant to the vice-president in 1936. He was elected a vice-president of the company in February, 1939.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Edward S. Allen, salesman, C. M. & W. O. Sheppard, Hood River, Ore. (Mail) 705 Cascade Ave.

R. H. Anderson, purchasing agent, New Holland Machine Co., 100 Franklin St., New Holland, Pa.

James H. Ard, assistant in agricultural engineering, Clemson Agricultural College, Clemson, S. C.

Charlie M. Baker, research assistant in agricultural engineering, Texas A. & M. College, College Station, Tex.

Kenneth V. Battles, extension agricultural engineer, Ohio State University, Columbus, Ohio.

S. C. Bhatnager, graduate student in agricultural engineering, Ohio State University, Columbus, Ohio. (Mail) 51 East 11th Ave.

E. R. Bolles, design engineer, agricultural engineering research dept., Hawaiian Sugar Planters' Ass'n, Honolulu, T. H. (Mail) 3556 A Lilinoe Pl.

Donald B. Brooker, research assistant in agricultural engineering, University of Missouri, Columbia, Mo. (Mail) 305 Melbourne.

Otto Burgdorf, farmer, R. R. No. 2, Box 680, Woodland, Calif.

G. S. Bedi, well supervisor, engineering section, Punjab Agriculture Department. (Mail) c/o Registrar, Kings' College, Newcastle-Upon-Tyne, England.

A. H. Bishop, agricultural engineer, UNRRA China Mission. (Mail) 2 Poatn Rd., Oakleigh Seia, Melbourne, Australia.

Elmer C. Burch, agricultural engineer, Kohala Sugar Co. (Mail) Halaula, Hawaii, T. H.

Lowell E. Campbell, junior agricultural engineer, Bureau of Plant Industry, Soils, and Agricultural Engineering, USDA. (Mail) North Building, Agricultural Research Center, Beltsville, Md.

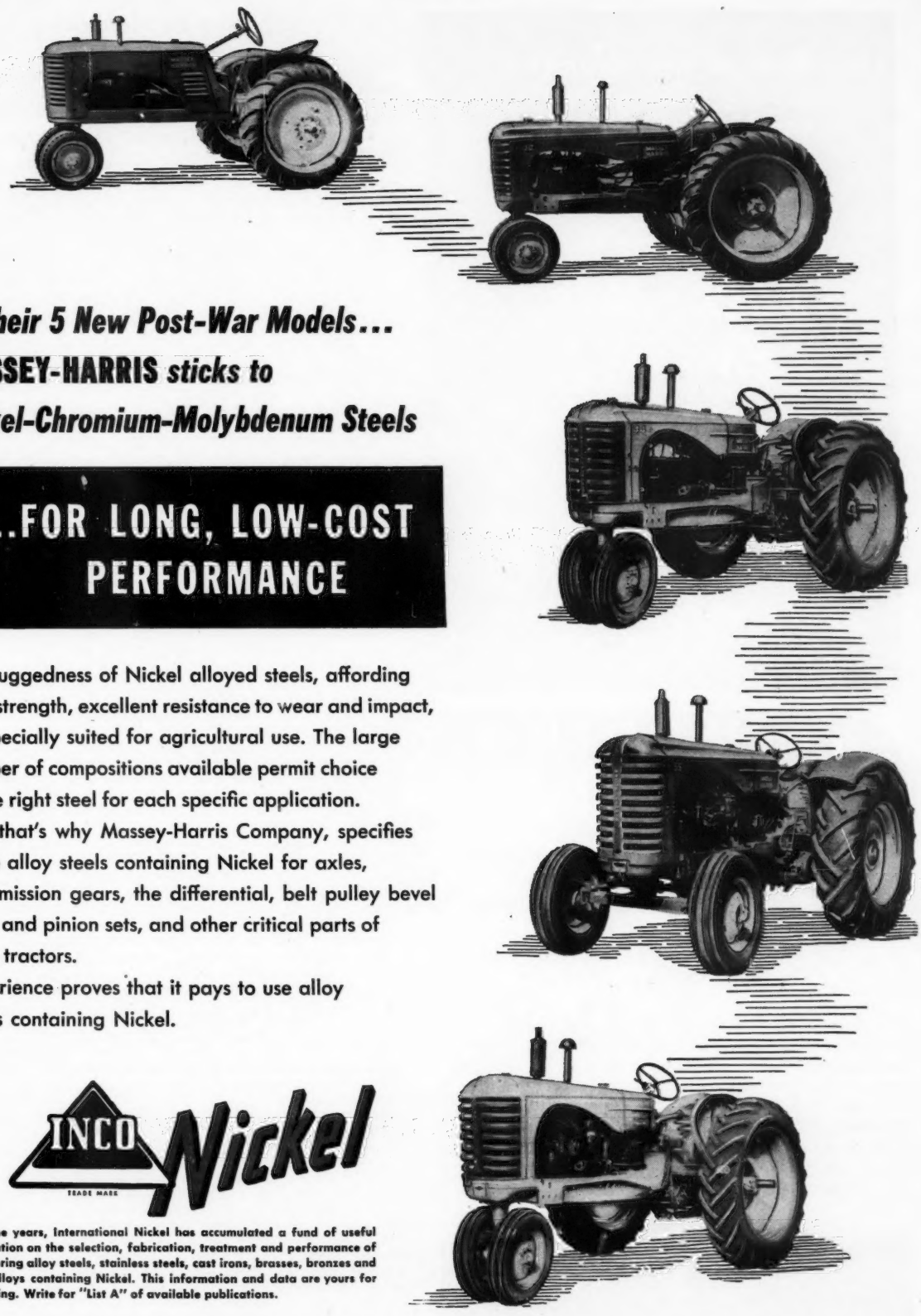
R. M. Cleveland, research fellow in agricultural engineering, Iowa State College, Ames, Iowa.

Harry L. Cook, agronomist, Ohio Farm Bureau Cooperative Assn., 245 North High St., Columbus 16, Ohio.

T. L. Coulthard, assistant professor of agricultural engineering and agricultural mechanics, University of British Columbia, Vancouver, B. C., Canada.

James O. Curtis, assistant in farm structures, University of Illinois (Mail) 105 South Wright, Champaign, Ill.

George E. Falb, engineer and designer, Mechanical Farm Equipment Co., R. R. No. 2, Orville, Ohio. *(Continued on page 574)*



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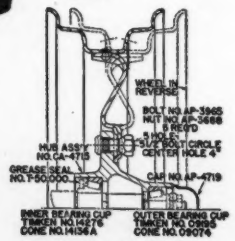
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NUT NO. AP-3668
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5 HOLE CIRCLE
CENTER HOLE 4"
HUB ASS'Y NO. CA-4715
GREASE SEAL NO. P-260000
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Wheel Builders Since 1888

Applicants for Membership

(Continued from page 574)

Rupert Gaigher, assistant professional officer, Soil Conservation and Extension, Box 965, Pretoria, South Africa.

Raul R. Guerrero, vo-ag instructor, Zapata County Vocational School. (Mail) Box N, Rio Grande City, Tex.

Marvin M. Halleck, farm and sports director, Radio Station WLEX, Lexington, Ky. (Mail) 320 Duke Rd.

Raymond A. Higginbotham, work unit conservationist and group supervising engineer, Soil Conservation Service, USDA. (Mail) Box 323, Spur, Tex.

A. R. Huntington, manager, Pest Control Ltd., 1396 Richard's St., Vancouver, B. C., Canada.

W. S. Jones, manager, tractor dept., Pierce Motor Co., Spartanburg, S. C. (Mail) 508 Perrineau St.

Leland W. Kelley, field representative, National Cotton Council of America. (Mail) 2 Mount Vista Ave., Greenville, S. C.

C. A. Kincaid, agricultural field engineer, Portland Cement Assn. (Mail) 510 S. Chicago Ave., Champaign, Ill.

D. Lehman, territory sales supervisor, J. I. Case Co., Ltd., Regina, Sask., Canada.

Ralph I. Lipper, assistant professor of agricultural engineering, Kansas State College, Manhattan, Kans.

Louis Lubinus, extension agricultural engineer, South Dakota State College, Brookings, S. D.

R. F. Malcolm, special tillage traveler, International Harvester Co. (Mail) 1413 West Main St., Galesburg, Ill.

Stephen D. Martin, instructor in soil conservation, agricultural engineering dept., A. & M. College of Texas, College Station, Tex. (Mail) P. O. Box 2144.

Louis G. McGill, field representative, Carolinas Ginner's Assn. (Mail) R. R. 6, Anderson, S. C.

Jack R. Morris, junior agricultural engineer, U. S. Department of Agriculture. (Mail) Agricultural engineering dept., University of California, Davis, Calif.

E. A. Oosthuizen, professional officer and lecturer in engineering, College of Agriculture, Potchefstroom, Transvaal, South Africa.

Rajendra M. Pahalwan, lecturer in agricultural engineering, Allahabad Agricultural Institute, Allahabad, U P, India.

Arnold F. Peterson, farmer, R. R. No. 1, Helix, Ore.

Jay G. Porterfield, instructor in agricultural engineering, Iowa State College, Ames, Iowa.

Erwin J. Raven, farm service advisor, Detroit Edison Co. (Mail) Lapeer, Mich.

Weston F. Raven, assistant foreman, Fairmont Food Co., Athens, Ohio. (Mail) 10 North Lancaster St.

John D. Sherck, farm products supervisor, Westinghouse Electric Supply Co., 547 Harper Ave., Detroit 2, Mich.

Arthur E. Sites, research engineer, Martin Steel Products Corp., Mansfield, Ohio. (Mail) 344 Shepard Rd.

C. Edwin Smith, sales promotion, J. I. Case Co. (Mail) R. R. No. 2, Carroll, Ohio.

W. L. Sparkman, R. R. No. 1, Dade City, Fla.

J. L. Stackhouse, Jr., graduate student in agricultural engineering, Cornell University, Ithaca, N. Y. (Mail) 108 East Yates St.

H. W. Stewart, agricultural engineer, Department of Agriculture, Government of Bihar, c/o Imperial Bank of India, Patna, India.

Richard O. Trapp, agricultural engineering student, Michigan State College, East Lansing, Mich. (Mail) 523 N. Chestnut, Lansing 15.

Sidney H. Usry, assistant research professor, North Carolina State College, Raleigh, N. C. (Mail) B-6, Raleigh Apartments.

Robert C. Wacker, manager, original equipment division, Blackhawk Mfg. Co., 5325 West Rogers, West Allis 14, Wis.

R. A. Weiler, assistant to chief engineer, The Midland Co., South Milwaukee, Wis. (Mail) P. O. Box 41.

J. W. Wilkins, agricultural engineering dept., University of Wisconsin, Madison, Wis.

James Y. T. Yu, graduate student in agricultural engineering, Iowa State College, Ames, Iowa.

TRANSFER OF GRADE

Earle F. Cox, design engineer, Allis-Chalmers Mfg. Co. (Mail) 316 Arthur Ave., Menomonie Falls, Wis. (Junior Member to Member)

George M. Hardy, sales engineer, R. S. Armstrong & Bros. Co., Atlanta, Ga. (Mail) 625 Sherwood Drive. (Junior Member to Member)

William J. Oates, professor of agricultural engineering, Oklahoma A. & M. College, Stillwater, Okla. (Junior Member to Member)

John S. Parker, in charge, water erosion control studies, Dominion Experimental Station, Swift Current, Sask., Canada. (Junior Member to Member)

C. E. Stevens, Jr., supervisor of soil conservation, Seabrook Farms. (Mail) R. R. No. 2, Elmer, N. J. (Junior Member to Member)

Harry Stierli, senior assistant engineer (R), U. S. Public Health Service Laboratory, P. O. Box 769, Savannah, Ga. (Junior Member to Member)

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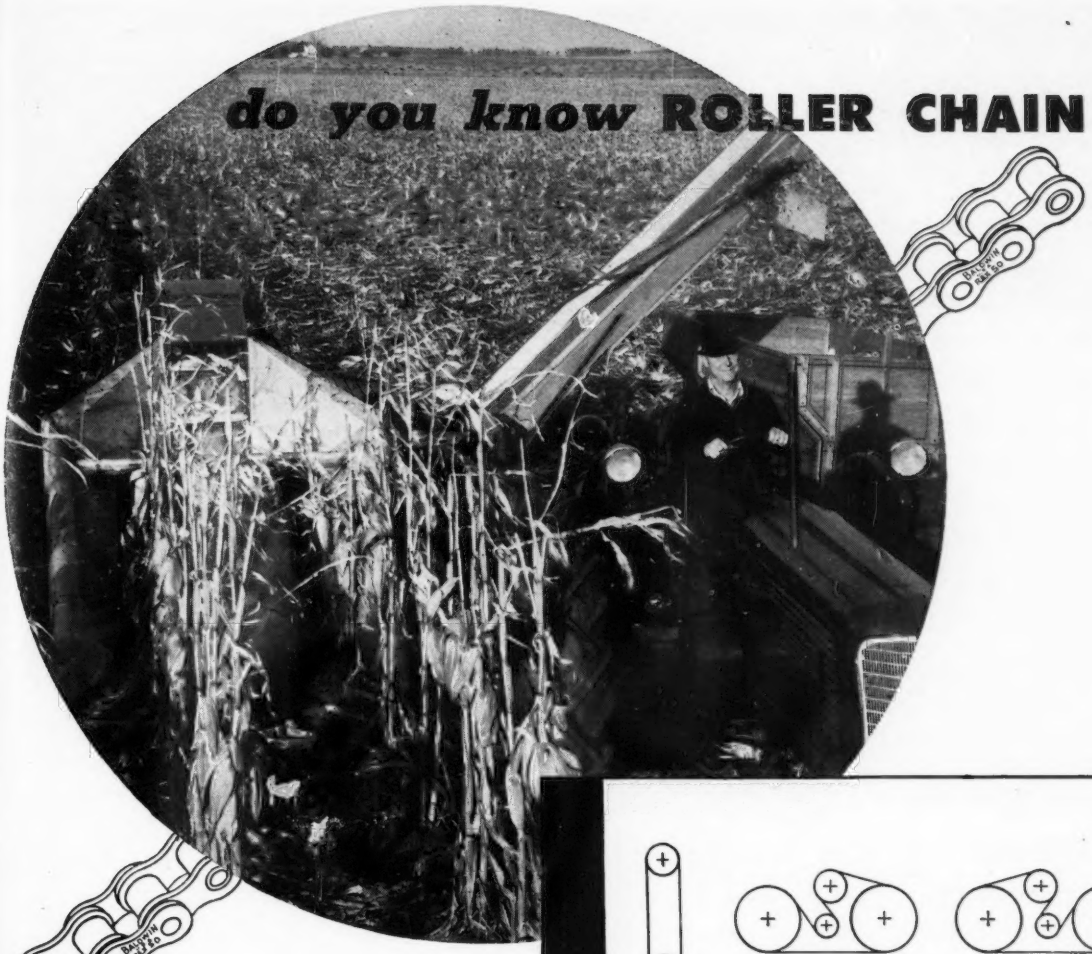

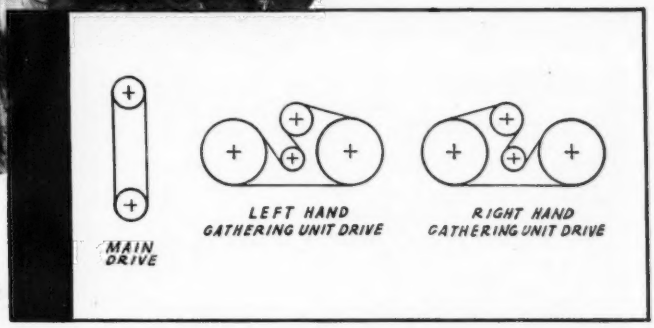

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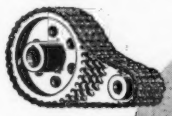

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Tremendously increased production capacity for our smaller sizes now enables us to offer our Models AB and AK engines (2 to 4 Hp.) for immediate delivery — in volume to manufacturers of power-operated equipment, or through authorized distributors and dealers on individual purchases.

These are heavy-duty, 4-cycle single cylinder engines that carry "Most Hp. Hours" service ratings. Equipped with tapered roller bearings at BOTH ends of the drop-forged, dynamically balanced crankshaft for long life and protection against bearing failure; high tension outside magneto with impulse coupling for quick, easy starting in any weather; pump-circulated constant level splash lubrication system (no grease cups or oil fittings). Net weight: Model AB, 76 lbs.; Model AK, 77 lbs. Speed range: Model AB, 1600-2600 rpm; Model AK, 1600-2400 rpm.

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Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this Bulletin the following listings still current and previously reported are not repeated in detail. For further information see the issue of AGRICULTURAL ENGINEERING indicated.

Attention is invited to the desirability of checking on the housing situation when considering a new location.

POSITIONS OPEN: 1946 JUNE — O-506. SEPTEMBER — O-516. DECEMBER—O-526. 1947 MARCH—O-543. APRIL—O-552. MAY —O-564. JUNE—O-567, 569, 571. JULY—O-574. AUGUST—O-576, 577, 579. SEPTEMBER—O-581, 582, 584. OCTOBER—O-585, 587, 588, 589, 590, 591. NOVEMBER—O-592, 593, 594, 595, 596.

POSITIONS WANTED: 1946 FEBRUARY—W-207. JUNE—W-320. SEPTEMBER—W-337. 1947 FEBRUARY—W-373. APRIL—W-389. MAY—W-395, 398, 101, 103. JUNE—W-105, 106. AUGUST—W-114. SEPTEMBER—W-119, 120. OCTOBER—W-124. NOVEMBER—W-125, 126, 127, 128.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER (junior, intermediate, or senior instructor rank) for teaching agricultural engineering and agricultural mechanics in a state polytechnic college in the Southwest. MS or PhD deg in agricultural engineering, or equivalent, and some research, teaching, or commercial experience in the field preferred. Age 25-45. Salary $3900 min to start. O-597

CHIEF ENGINEER to take full control of farm tractor and equipment engineering for established manufacturer in California. Experience in responsible position in tractor and equipment design, and handling of men required. Usual personal qualifications for engineering executive. Salary open. O-598.

AGRICULTURAL ENGINEER with farm structures background to assist chief engineer of eastern consulting organization in the agricultural field. Must be good designer, top-notch draftsman and capable administrator, with pleasing personality and ability to express himself verbally and in writing. Limited travel in setting up and supervision of field research and college contacts. Unique opportunity and exceptional working conditions. Promising young man not excluded if capable of rapid development. Starting salary high. O-599.

AGRICULTURAL ENGINEER for research, production and introduction of improved equipment, etc., as member of an American team in the United Provinces of India. Knowledge of foreign language not required. Experience in foreign country desirable but not essential. Formal educational preparation considered along with other qualifications. Experience in associated rural problems and extension methods desirable. Must have ability to work under primitive conditions; active interest in the people; ability to size up a situation from limited information, draw up a program and act on it. Three-year contract with Government of Provinces. Leave USA in April or May 1948. Age, under 45. Salary $7,500-$10,000 range, payable in U. S. dollars, fare both ways, local travel expenses, 30 days leave. O-600.

HEAD FIELD WORKER in agriculture and rural planning and reconstruction, for demonstration and introduction of improved methods among small scale farmers, as member of an American team in the United Provinces of India. County agent type of experience desired. Experience in farm cooperatives helpful. Other conditions and requirements as in O-600, above. O-601.

SPECIALIST IN VILLAGE-LEVEL RESEARCH AND RURAL ENGINEERING for collecting and evaluating data on existing work; and original research on building methods and simple mechanical and sanitary devices, with locally available materials and skills, to improve village living and economic conditions. Other conditions and requirements as in O-600, above. O-602

WATERSHED PLANNER, for multipurpose hydroelectric developments of moderate size, including irrigation; apportionment of power; location, amount, and type of industry; relocation of displaced people; creation of new villages; recreation, reforestation, and agricultural development, as member of an American team in the United Provinces of India. Other conditions and requirements as in O-600 above. O-603

SALES ENGINEERS (2) for work with established eastern wholesale distributor of specialized farm machinery. BS deg in agricultural engineering or equivalent preferred. Previous sales experience required. Age 25-50. Salary and commissions would average $5,000-$8,000 annually, with all expenses paid. O-604

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER desires rural electric service work with private company. BS deg in agricultural engineering, 1943, Louisiana State University. Air Corps enlisted and commissioned service. Experience since February 1946 as rural service representative of an electric utility. No physical defects, available two months after acceptance. Married. Age 26. Salary open. W-129

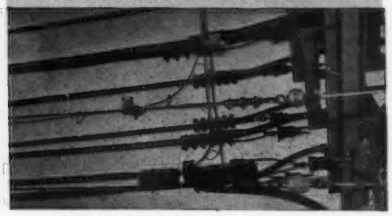
AGRICULTURAL ENGINEER desires sales or service work in power and machinery or farm structures field, with private company. BS deg in agriculture, with major in agricultural engineering, University of Florida, July 1947. Rodman for AAA soil conservation work 9 months. Enlisted and commissioned war service in Naval Reserve. No physical defects. Available immediately. Single. Age 23. Salary $3,000. W-130

(Continued on page 280)

INSTALLED IN 1905, this 250-volt D.C. feeder is giving good service. Conductors are 1,590,000 c.m. aluminum T.B.W.P. cables.

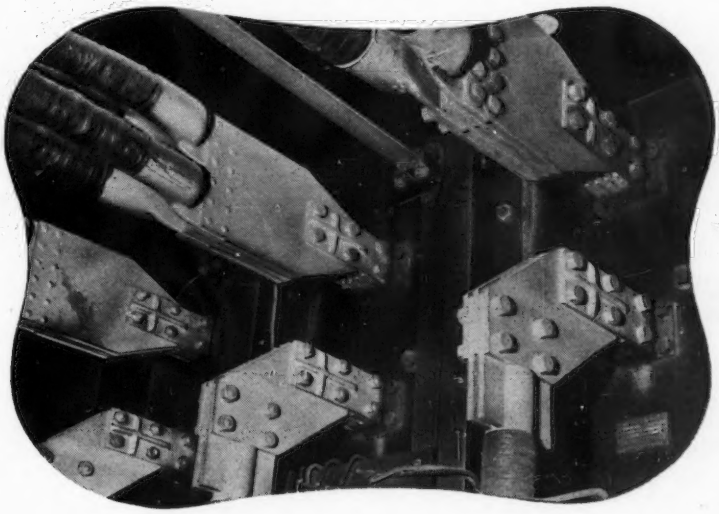
BOLTED DEAD-ENDS on 1,590,000 c.m. aluminum T.B.W.P. cable (Bottom conductors) installed in 1913 in a machine shop for 250-volt feeder.

YARD LINE installed in 1915. Bolted run and soldered tap, aluminum T connectors shown alongside parallel groove clamps installed for later temporary taps.

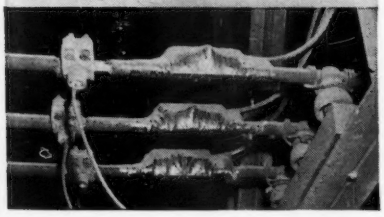


1,590,000 C.M. aluminum T.B.W.P. cable 2200-volt feeder along river. Original aluminum T connectors, bolted run and soldered tap, installed in 1915.

450-VOLT D.C. Line carrying 1390 amperes per cable in a Rotary Converter Station. Four 1,590,000 c.m. aluminum T.B.W.P. cable connections to switchboard using soldered copper lugs. 1700 lugs installed in 1916. Less than 5% of lugs have been resoldered.



220-VOLT 3-phase A.C. Feeders in use since 1915 in a carbon plant. Original aluminum T connectors from 795,000 c.m. aluminum T.B.W.P. cable to No. 8 copper tap. Parallel groove tap under tape made at later date.



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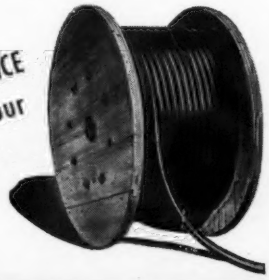
The BIG DIFFERENCE is in your COSTS



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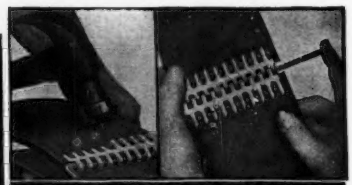
BELT LACING and FASTENERS for transmission and conveyor belts



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STEEL BELT LACING

World famed in general service for strength and long life. A flexible steel-hinged joint, smooth on both sides. 12 sizes. Made in steel, "Monel Metal" and non-magnetic alloys. Long lengths supplied if needed. Bulletin A-60 gives complete details.

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BELT FASTENERS AND RIP PLATES

For conveyor and elevator belts of all thicknesses, makes a tight butt joint of great strength and durability. Compresses belt ends between toothed cupped plates. Templates and FLEXCO Clips speed application. 6 sizes. Made in steel, "Monel Metal", non-magnetic and abrasion resisting alloys.

By using Flexco HD Rip Plates, damaged conveyor belting can be returned to satisfactory service. The extra length gives a long grip on edges of rip or patch. Flexco Tools and Rip Plate Tool are used. For complete information ask for Bulletin F-100.

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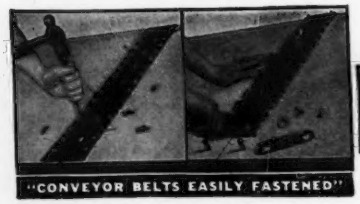

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RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

PERSONNEL SERVICE BULLETIN

(Continued from page 278)

AGRICULTURAL ENGINEER desires farm power and machinery development work with private company. BS deg in agricultural engineering expected Dec. 1947, Michigan State College. Five summers as farm hand. Three months as bearing scraper in foundry. Some part time teaching experience while in college. Noncommissioned officer experience in Army. No physical defects. Available Jan. 1, 1948. Married. Age 27. Salary open. W-131

AGRICULTURAL ENGINEER desires design, development, sales, or service work in farm power and machinery field with private company. BS deg in agricultural engineering expected Feb. 15, 1948, University of Illinois. Naval service as aviation cadet. Two summers setting up farm machinery for manufacturer. No physical defects. Available March 8, 1948. To be married in February 1948. Age 23. Salary open. W-132

AGRICULTURAL ENGINEER desires research or development work in refrigeration industry, or teaching thermodynamics in college. BS and MS deg in agricultural engineering, Pennsylvania State College. MS completed February 1946. Employed since then in design, development, production, and sales engineering on milk coolers, freezers, and sectional commercial refrigeration equipment. War service in Army Air Force. No physical defects. Available March 1, 1948. Married. Age 25. Salary open. W-133

AGRICULTURAL ENGINEER desires development or service work in farm structures field, with private company. BS deg in agricultural engineering expected December 1947, Iowa State College. Three summers draftsman and surveyor, U. S. Soil Conservation Service; one year as apprentice carpenter. Enlisted and commissioned war service in Infantry. Wounded in action. Amputation of right leg below knee. Disability largely corrected by prosthetic appliance. Available Jan. 1, 1948. Married. Age 25. Salary $3,000. W-134

New Federal and State Bulletins

Electric Welders on the Farm and Their Effect on Rural Power Distribution, by G. H. Foster. Washington State College (Pullman) Bulletin No. 487 (May 1947). Nine welders on a line serving 40 farms developed no serious peak load problems.

How to Fertilize Corn Effectively in Indiana, by G. D. Scarseth, H. L. Cook, B. A. Krantz, and A. L. Ohlrogge. Purdue Agricultural Experiment Station (Lafayette, Ind.) Bulletin 482 (rep). This bulletin was originally published in July, 1944. No additions or changes to the original contents are indicated. A number of illustrations in color are included.

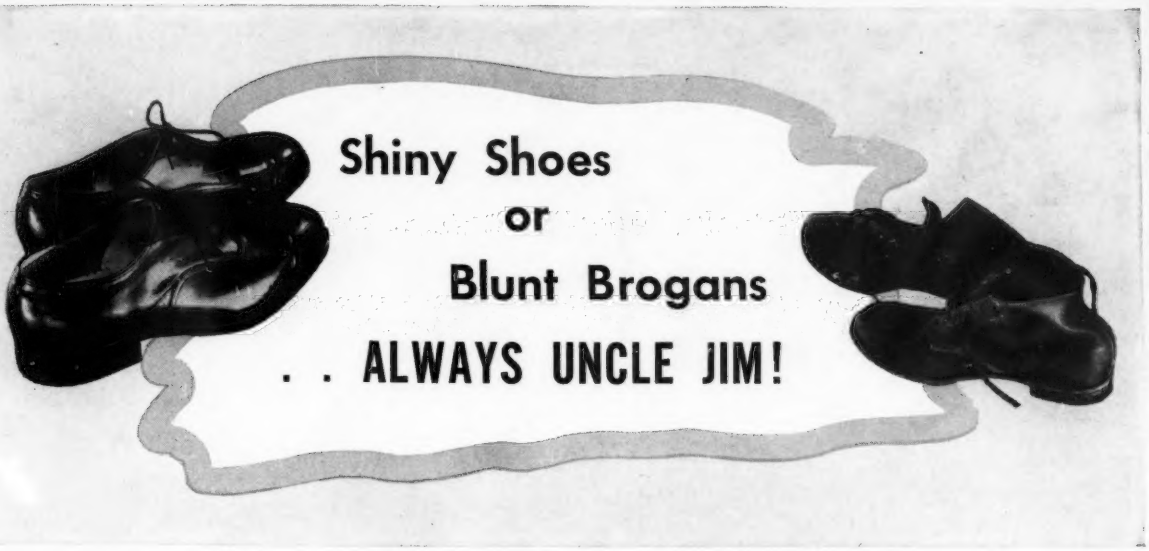
Septic Tanks for Rural and Suburban Areas, by John M. Hepler, George Amundson, Clare A. Gunn, and Walter Sheldon. Michigan State College Extension Bulletin 118 (third revision) and Michigan Department of Health Engineering Bulletin 2.

New Literature

PRACTICAL ELECTRICAL WIRING, by H. P. Richter. Cloth, X + 574 pages, 5½ x 8 inches. Illustrated and indexed. Third edition. McGraw-Hill Book Co., Inc. (New York) $3.75.

This edition revises the previous work to bring it into line with the 1947 National Electrical Code, and otherwise to bring it up to date as to methods, materials, and equipment now available. Explanations of principles have been further clarified. Chapters are grouped into three parts covering theory and basic principles, residential and farm wiring, and non-residential projects.

PLANNING THE DAIRY BARN. Educational Service Bulletin No. 5. Paper 16 pages, 6 x 9 inches. Illustrated. Barn Equipment Association. (Board of Trade Bldg., Chicago, Ill.). Concise practical information on planning the dairy barn layout, investment cost, mistakes to be avoided, planning the barn space, basic arrangements, floors and mangers, drainage, walls and ceilings, labor saving equipment, remodeling, and pen barns.



You could always depend on him to do things extra-well — whether slicked up in his best bib and tucker at a county meeting or working like a Trojan down in the south eighty — because, regardless of clothes he was always the *same Uncle Jim* — always doing things faster and a little better than most people.

It's like that with New Department ball bearings. You can have them dressed up with shields or seals to keep out dirt, or with snap rings for simplified location or many other useful features, but basically you always have one of the most valuable and thoroughly dependable workers for *mechanized* farming ever devised.—Taking loads, radial or thrust, locating parts accurately — cutting down friction and wear — All in a compact unit requiring no time wasting adjustments or attention.

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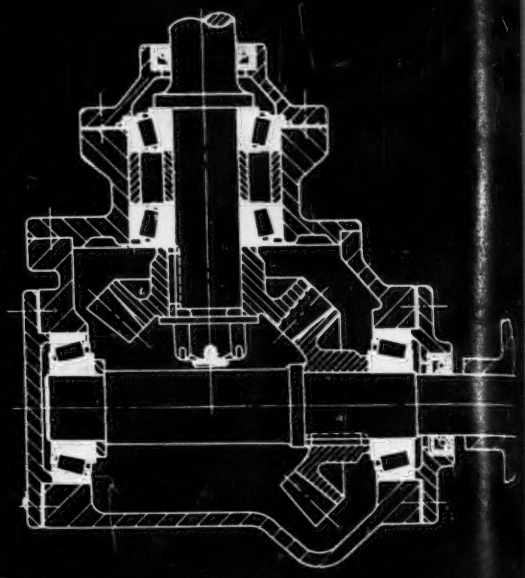

FIG. 1

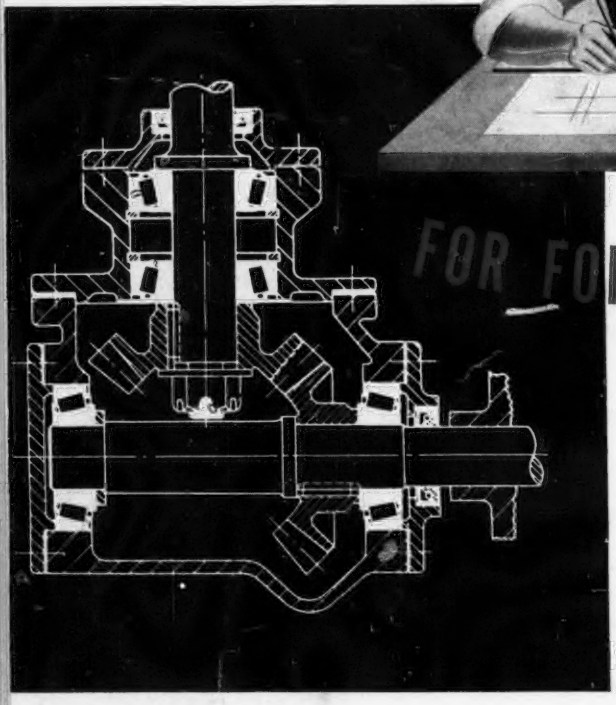

FIG. 2

FOR FORWARD LOOKING ENGINEER

In numerous farm implements it is necessary to change the direction of applied power. Maintenance of gear tooth contact, compact assembly, and freedom from more than routine maintenance are among the desirable characteristics.

In Figure 1 is shown a simple application of Timken Bearings to a right angle drive using a flanged cup on the pinion shaft. Spacers and shims are used to obtain the proper bearing set-up on the pinion. Bearing set-up and gear contact on the gear shaft are obtained by the use of shims. Pinion adjustment is made by shims between the flange on the outer cup and the housing.

In the design shown in Figure 2 the pinion bearings are located against snap rings engaging recesses in the housing. The bearings on the gear shaft are mounted the same as in the preceding design. Gear contact is obtained by means of shims.

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